Compressed Air Magazine

Vol. XXXII, No. V London New York Paris 35 Cents a Copy

MAY, 1927

CIRCULATION THIS ISSUE
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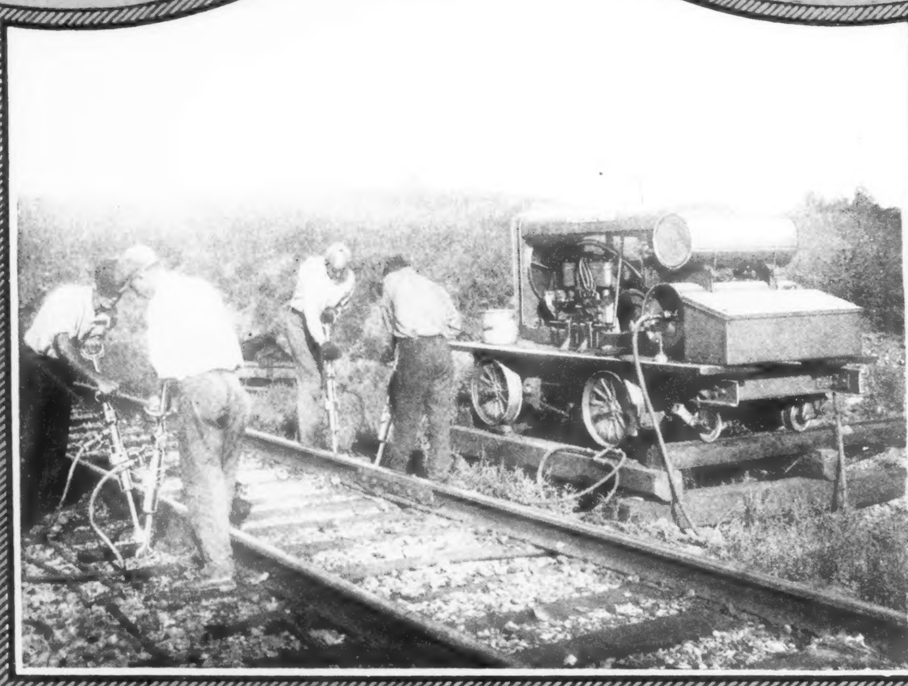

MODERN PNEUMATIC TAMPING OUTFIT SHOWING PORTABLE TIE-TAMPER AIR COMPRESSOR AT SIDE OF TRACK

(TABLE OF CONTENTS AND ADVERTISERS' INDEX, PAGE 5)

CONTENTS OF THIS ISSUE

Vol. XXXII, No. 5, May, 1927

NOTE—For subscription terms see first Editorial page

Articles

Advertisements

X-71 Hammer Drills on Tripods putting in 26-ft. horizontal snake holes.

"Jackhamer" Drills preparing boulders for "pop-holing."

X-71 Drill working on a bench.

X-71 Hammer Drill.

122,000,000 TONS of

The forward march of the crushed stone industry continued through the past year with a total production of 122,000,000 tons—an increase of 11½% over the 1925 output.

The annual increase has gone hand in hand with the increased use of compressed air machinery. Modern air-operated machines have not only made INCREASED PRODUCTION possible, but have DECREASED COSTS.

Ingersoll-Rand machines played an important part in this enormous output, and it is natural that they should. I-R engineers are acquainted with quarrying conditions and rock drilling problems all over the world. They fostered the change from steam to compressed air, giving the quarry industry an efficient hammer drill that replaced and did the work of three large piston drills.

Probably the most important step in the progress of the crushed stone industry has been the perfection and introduction of the wagon mounting for the hammer drill. This outfit is easily moved about, is more efficient, and requires fewer changes of steel. 200 to 300 feet of hole per shift is just an ordinary run.

Other labor-aiding machines which have helped to increase production and decrease costs are:

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VOL. XXXII, NO. V

MAY, 1927

Air-Lift System And Oil-Engine Power Make Dependable Water Plant

Allenhurst, N. J., Benefits As a Summer Resort By Supplying a Fluctuating Population With Ample Water For All Needs

By C. H. VIVIAN

THE Borough of Allenhurst is one of the popular seaside summer-residence communities of the northern New Jersey coast. Nature generously endowed the site, and man has done much towards making it a section of great attractiveness. The resort is notable for its clean, well-ordered general appearance; for its fine homes set off to advantage by careful landscaping; for its wide, tree-lined streets; and for its winding boulevards skirting the ocean front and the picturesque Deal Lake that separates the borough from its neighbor to the south, Asbury Park.

Allenhurst is not the hurdy-gurdy type of beach town. In fact, it is distinguished quite as much by the class of people who summer there as by the sort of houses they occupy. It is not an amusement center for the itinerant week-end vacationist and the attendant passing throngs, but rather the part-time abode of families prominent in the business and social lives of New York and other large cities near by.

Like all summer resorts, Allenhurst experiences marked seasonal fluctuations in population. In winter its inhabitants dwindle to less than 400 persons, and most of its fine houses are tenantless. But each succeeding spring gives it new life; and throughout the warm-weather months Allenhurst is a thriving community of some 4,000 residents, together with a sprinkling of guests who are accommodated at the spacious hotel that caters to transients.

It will be readily apparent that the water-supply problem of Allenhurst is not a simple one. The season of greatest population is likewise the period of maximum demand for water. This combination of conditions makes it necessary that from four to five times as much water be available at the taps in July and August as in January or February. This means that the supply and the plant that handles the water must be ample to take care of peak requirements, and that the plant—in the interest of operating economies, be flexible enough to permit of easy adjustment to meet the varied demands made upon it. Allenhurst has succeeded in solving its problem satisfactorily by using an air-lift system operated by oil-engine power; and the results obtained are worth while noting for the information of other communities that may be confronted with more or less similar conditions.

ONE might almost measure the march of civilization of a nation by the extent of the progress it has made in supplying its cities and towns with adequate quantities of pure water. It is a significant fact that those communities that have satisfactorily solved this problem are the ones that make the greatest appeal to the homeseeker.

It is the assurance of a plentiful supply of pure water that is year by year making Allenhurst, N. J., more popular as a summer resort; and it is interesting to note that, by keeping pace with developments, the water-supply system of this attractive community has at all times been equal to the increasing demands made upon it.

In line with this far-sighted policy, and to meet the needs of the steadily growing population, the borough decided not long ago to still further improve the plant by installing an oil engine to drive the essential pumping machinery. The records, covering an operating period of eight months, speak for themselves—disclosing as they do noteworthy economies in operating costs.

There are two distinct sources of water supply at Allenhurst. Water for irrigation, fire, and industrial purposes is drawn from Deal Lake, while the domestic supply comes from wells which tap a sandstone stratum lying 550 feet below the surface of the ground. Likewise, there are separate distributing systems; and the domestic supply is on meters.

The well water is characterized by high purity—a fact of which the borough officials are justly proud and one which has served in no small measure to popularize the community as a summer resort. Samples are taken at regular intervals and tested to determine whether or not the water is free from pollution.

The sandstone horizon which yields the potable water also serves as the source of supply for several other adjacent communities. It is of a fine-grained texture and lies between beds of marl and clay. The water from it carries considerable quantities of silt in suspension and, therefore, any system for pumping it must be of a type embodying few parts subject to abrasive wear. While there is considerable rock and hydrostatic pressure on the water sand, the pressure is not sufficient to

Left—The fine and spacious summer hotel at Allenhurst.
Right—Home of Commissioner C. R. Zacharius.

cause the water to reach the surface as an Artesian flow. Accordingly, it must be raised the remaining distance through suitable installations.

The first of the wells was drilled in 1894, and for eight years thereafter pumps were relied upon to bring the water to the surface. In 1902 the air-lift principle was applied, and has been used ever since with success. There are five wells at the present time. All are within a circle having a radius of a few hundred feet—the farthest being approximately 1,000 feet from the pumping station. The normal water level in the wells is 38 feet below the ground surface, but this water line drops a maximum of 19 feet when the heaviest withdrawals are being made.

Three of the wells are cased with 8-inch pipe and the other two with 4-inch pipe. Within the casings, and extending to depths of 250 feet, are the discharge pipes. As depth is reached, the size of the discharge pipes is graduated—the uppermost sections of those in the larger wells being 4 inches in inside diameter and of those in the smaller wells being 2½ inches in internal diameter. These pipes extend through caps which seal the upper ends of the enclosing casings. The air line likewise pierces this cap and extends downward within the casing for 250 feet, making connection at the lower end with the discharge pipe. The larger wells are served by 1-inch lines, while the smaller wells have ¾-inch lines.

The principle of the air lift is so well known that it requires but a brief explanation. The air, entering the column of water in the discharge pipe, diffuses upward in the form of bubbles, lightening the mass of water to such an extent that the hydrostatic head on the outside of the discharge pipe is able to exert the required pressure to lift the aerated column to the surface and to produce a continuous flow.

The use of the air lift for drawing drinking water from wells has numerous advantages. From the standpoint of health, aeration improves the quality of the water. From the practical angle, the air lift offers a medium for large-capacity pumping at a cost which, over a period of years, is generally lower than that of any other system of pumping from deep wells. As there is nothing to break down or to deteriorate, the air-lift system is extremely reliable.

These facts, together with the flexibility of the system, moved the officials of Allenhurst to decide on the air-lift system of pumping. Suffice it to say that they have been pleased with their choice; as there has never been a time since its installation when the water supply has been threatened with failure. The assurance of plentiful quantities of pure drinking water was an important factor in causing many persons to locate their summer homes at Allenhurst; and it still continues to exert a strong influence in that direction.

Improvements have been made as needed in the mechanical equipment furnishing the air for pumping the wells; and each one has resulted in a more economical plant. As other communities rely upon the same water stratum, the static head has decreased gradually throughout the entire region. This condition, together with the growing local demand for water, has made it advisable to install more powerful equipment from time to time.

The first compressor plant consisted of an 11 and 11x12-inch Type XB-1 machine having a maximum rating of 55 pounds to the square inch. It answered the purpose very well for 20 years, but during the last 18 months of its use it had to be operated at about 20 per cent.

Some of Allenhurst's palatial homes. At the left, the residence of Mayor William E. Selby.

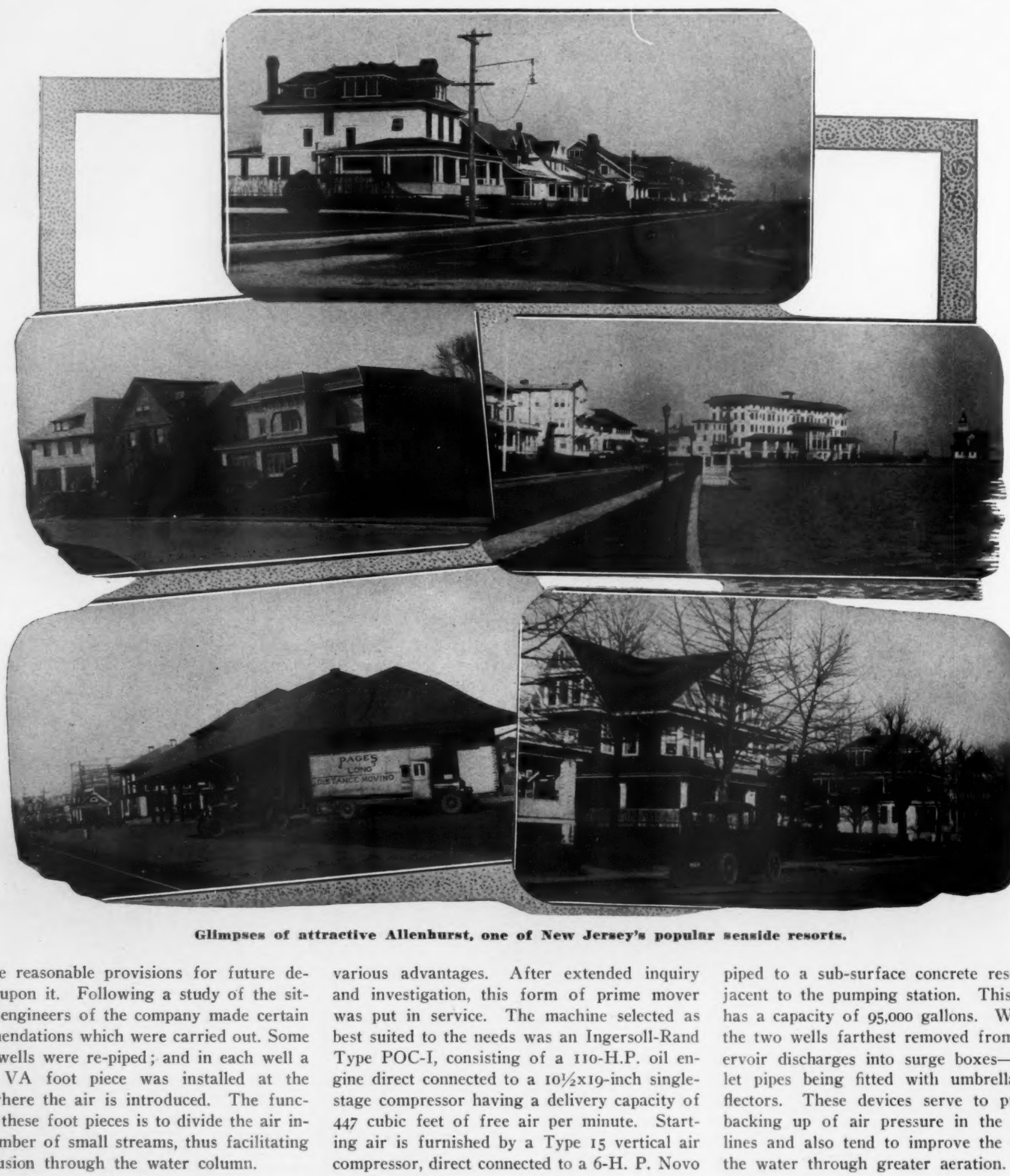
Pumping equipment in the water works of the Borough of Allenhurst.

1—Instrument board and Type 15 compressor which furnishes starting air for the oil-engine compressor.
2—Electrically-driven Cameron pump that handles 3,000 gallons of water a minute for sprinkling lawns, for fighting fire, for supplying garages, etc.
3—Showing compact arrangement of the POC-1 unit and the pump, which operate free from dirt and smoke.
4—The Cameron 600-gallon-per-minute pump, used for handling well water, is short belted to the oil-engine flywheel.
5—The POC-1 unit viewed from the oil-engine end. The Maxim silencer and the air receiver are in the background.

overload in order to supply the air required to pump the greater volume of water demanded by an increasing population. Also, the water level in the wells had dropped in the interval, thus calling for a higher air pressure than the 35 pounds at the receiver which was ample when the unit was purchased.

In 1922, the Ingersoll-Rand Company was commissioned to bring the plant up to date and sure of 46 pounds to deliver 124.2 gallons of water per minute was so far improved as to yield 126.8 gallons per minute at a working pressure of 42 pounds and with an air consumption of 56.3 cubic feet per minute. The saving in air thus effected amounted to 52.5 per cent. This plant gave good service. However, in 1926, it came to the attention of the borough officials that oil-engine power offered pounds, being momentarily raised to approximately 105 pounds just before the wells "break" and start flowing. The POC-1 unit not only supplies the air for raising the water to the surface, but it also drives the pump that lifts the water to a distribution standpipe. Before further discussing the oil engine, let us complete the general description of the system.

The water, upon issuing from the wells, is



Glimpses of attractive Allenhurst, one of New Jersey's popular seaside resorts.

to make reasonable provisions for future demands upon it. Following a study of the situation, engineers of the company made certain recommendations which were carried out. Some of the wells were re-piped; and in each well a No. 4 VA foot piece was installed at the point where the air is introduced. The function of these foot pieces is to divide the air into a number of small streams, thus facilitating its diffusion through the water column.

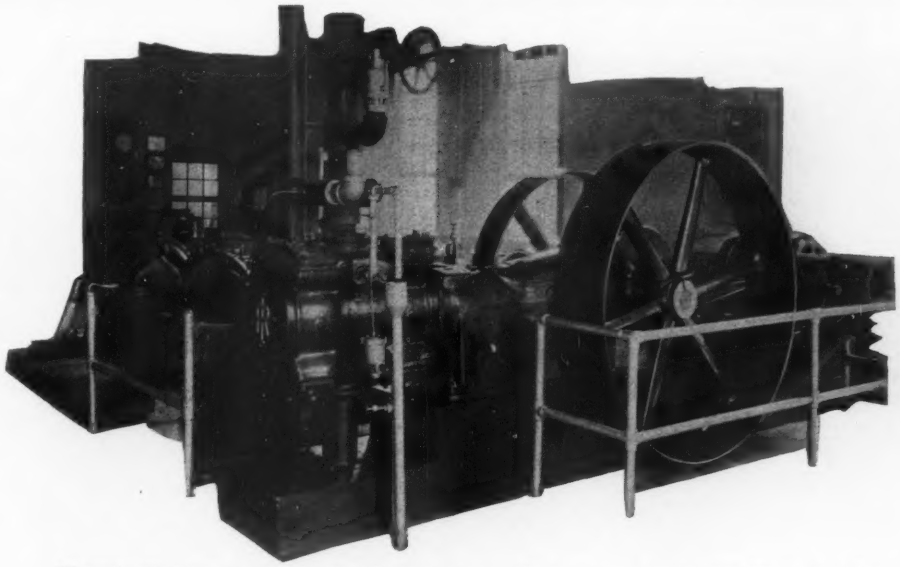
An electrically-driven Type ER-1 air compressor supplanted the older unit. Marked increases in efficiency were at once noted. A well which previously had required 117 cubic feet of free air per minute at a working pres-

various advantages. After extended inquiry and investigation, this form of prime mover was put in service. The machine selected as best suited to the needs was an Ingersoll-Rand Type POC-I, consisting of a 110-H.P. oil engine direct connected to a 10½x19-inch single-stage compressor having a delivery capacity of 447 cubic feet of free air per minute. Starting air is furnished by a Type 15 vertical air compressor, direct connected to a 6-H. P. Novo gasoline engine.

Before entering the pipe lines leading to the wells, the air passes into a receiver of suitable size. During pumping the air in this tank is maintained at a pressure of from 85 to 90

piped to a sub-surface concrete reservoir adjacent to the pumping station. This reservoir has a capacity of 95,000 gallons. Water from the two wells farthest removed from this reservoir discharges into surge boxes—their outlet pipes being fitted with umbrella-type deflectors. These devices serve to prevent the backing up of air pressure in the horizontal lines and also tend to improve the quality of the water through greater aeration.

From the surge boxes the water flows by gravity into a concrete settling basin. This is fitted with a removable transverse baffle which causes the precipitation of the sand and silt carried in suspension and allows the water to



Electrically-driven, Type ER-1 compressor that serves as an auxiliary in the Allenhurst pumping station.

pass on over the top. A 10-inch gravity-flow main leads from the settling basin to the reservoir previously mentioned. From the reservoir the water is pumped to a 125-foot steel standpipe having a capacity of 210,000 gallons. On its way to the standpipe it passes through a 2-unit filtration plant. The standpipe is connected directly with the distributing mains—the gravity pressure being sufficient to throw a stream of water well over the top of the highest building in the borough.

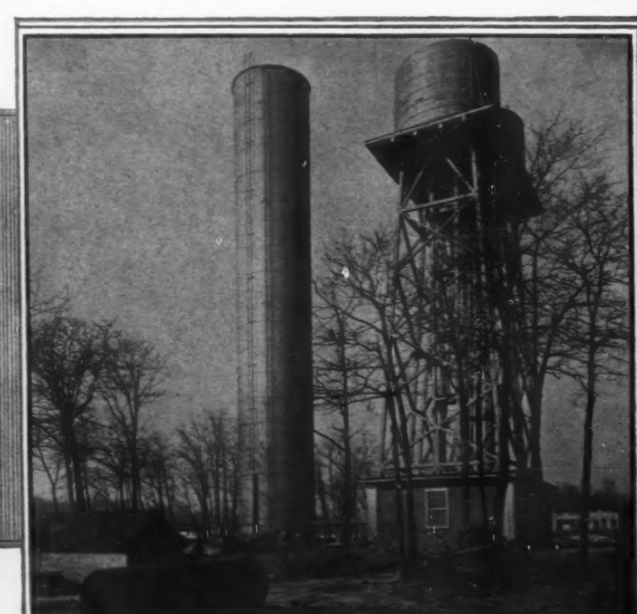
A Cameron, single-stage unit, short-belted to the oil-engine flywheel, is used to pump the water from the reservoir to the standpipe. This unit has a capacity of 600 gallons per minute against a 130-foot head. With both the pump and the air compressor powered from the same source, it is easy to make adjustments and thus at all times to maintain proper speed relations between them. For auxiliary or standby service, the equipment which formerly carried the burden has been retained. The compressor is belt-driven from a 79-H.P. motor. The reserve pumping units consist of two centrifugal pumps, of 750- and 1,000-gallons-per-minute capacity, respectively. Both are driven by motors.

The lake water is pumped directly from Deal Lake to two wooden distributing tanks elevated to a height of 90 feet above the ground. Each has a capacity of 50,000 gallons. The pumping equipment for this end of the plant operations consists of a Cameron No. 10 HV centrifugal pump having a capacity of 3,000 gallons per minute against a 127-foot head, and of two Cameron pumps, of similar design, each of 750-gallons-per-minute capacity against a 140-foot head. The two smaller units can be connected in series to give additional capacity when it is desired. These units are all motor driven.

The savings that have resulted from the use of the oil-engine unit are impressive and have been the source of great satisfaction to the borough officials, who also have been highly pleased with the complete absence of breakdowns or even momentary interruptions in service. During the eight months from July 1, 1926, when the POC-1 was put in service, to March 1, 1927, the power bills—plus the cost of fuel and lubricating oil for the oil-engine unit—totaled $1,227.16. In other words, this sum represented the entire cost of operating the pumping station. During the corresponding months of the three years immediately preceding, when the plant was electrically driven, the power bills averaged $4,115.47. The saving due to the oil-engine installation thus amounts to $2,888.31. The indicated saving for a year's time is more than $4,000. It is readily apparent, therefore, that the price of the new machinery will soon be returned in lower operating costs.

In compiling the aforementioned figures, the lubricating oil used during the last six months of 1926 was based on a cost of $20 a month. On January 1, 1927, an oil-filtration system was installed, and this has cut the lubricating-oil consumption to approximately 1 gallon for every 15 hours of engine operation. The economies in the future will, therefore, be even greater than those indicated in the foregoing comparison of costs.

The average daily period of operation of the engine has been but 4.63 hours, varying from about 9 hours a day in August to slightly more than 2 hours in February. It is obvious that the unit is in use only approximately 20 per cent. of the time, which means that there is ample reserve power for future needs. For the present, also, it means that there is little wear and tear on the installation, insuring long service. For the heaviest day's work, accord-



Left—Two of the largest of the wells at Allenhurst are provided with surge boxes, as illustrated. In the background is picturesque Deal Lake, one source of Allenhurst's water supply.
Right—Where the water is stored for distribution through the supply mains. The building at the right houses the filtration plant.

The men responsible for the operation of the Allenhurst water-supply system. From left to right: C. R. Zacharius, commissioner of public works; R. S. Burdge, chief engineer of the pumping station; and James Hennessey, superintendent of public works.

ing to the plant records, the cost of fuel oil was but $3.30.

The following resumé of the first eight months of operation, gives the salient points which demonstrate the low cost of operation:

Total gallons of water pumped......	44,244,500
Cost of fuel oil per 1,000,000 gallons of water pumped	$7.92
Cost of fuel oil per hour of operation at 6 cents a gallon	0.321

C. R. Zacharius is the borough commissioner in charge of public works, and James Hennessey is superintendent of the water, street, and sewer departments of Allenhurst. To quote Mr. Hennessey:

"We realize that the POC-I oil-engine installation is saving us hundreds of dollars annually, and we are highly pleased with its operation from the standpoints of dependability, efficiency, and economy."

SPONGE IRON DIRECT FROM ORE BY NEW PROCESS

THE production of granular or sponge iron from ore without the aid of the blast furnace is engaging the attention of the Lorain Works of the United States Steel Corporation. The process is based on preheating, reducing, and cooling iron ores in rotary kilns in successive stages and at a temperature low enough to prevent fusion.

After the ores have been crushed, they are charged into a rotary kiln heated to a definite temperature. Then they are passed into a second rotary kiln, mixed with coal, and heated to a higher temperature. Thence they go to a third rotary kiln, where they are subjected to sudden cooling. The results so far obtained have been very encouraging—an iron of 98 per cent. purity having been produced.

PORTABLE COMPRESSOR AND PUMPING OUTFIT

CONTRACTORS, especially, will be interested in the announcement recently made by the Ingersoll-Rand Company that it is prepared to furnish a portable unit combining an air compressor and an air-driven pump. There has been a long-felt want for a pump that could be conveniently transported and that would be ready for service on reaching the job.

The pumping equipment now used by contractors, public utilities, etc., ordinarily consists of a pump and a separate prime mover—usually a single-cylinder gas or oil engine. This means the shifting from place to place and the setting up of two pieces of machinery. And, if compressed air is required—as is generally the case where excavating for one purpose or another has to be done—a third piece of machinery is necessary.

The new portable unit not only furnishes the pump but, likewise, the compressor ready on short notice either to handle water or to supply operating air for "Jackhamers," paving breakers, clay diggers, hoists, drill-steel sharpeners, or for whatever pneumatic equipment that may be needed to do the particular work in hand.

Our illustration shows a Type Twenty, gasoline-engine-driven compressor and a Cameron air-driven pump both compactly mounted on the steel frame of the compressor—the steel frame, in turn, being mounted on wheels. The pump is positive in its action; it requires no priming; and starts up as soon as the air is turned on. By simply controlling the flow of the air, the pump can be made to handle any amount of water within the limits of its rated capacity. As can be readily appreciated, the pump is especially suitable for removing overnight accumulations of water in foundations, trenches, and the like, and for furnishing water to concrete mixers—in short, for many services calling for the handling of moderate quantities of either clean or muddy water.

Compressor-pump outfits of the type described are manufactured in several sizes; but, to save the duplication of machinery, the pumps may be purchased separately and attached to any Ingersoll-Rand portable compressor by means of parts especially provided for that purpose.

Rear view of portable compressor illustrating the manner in which the air-driven pump is mounted.

PETROLEUM PRODUCTION ON THE INCREASE

THE petroleum production in the United States in 1926 is estimated at 773,000,000 barrels—the greatest annual output in the nation's history, or 1.2 per cent more than that for 1925, the previous record year. The 1926 production was characterized by a steady increase—the daily average for each month being larger than that for the month just preceding. This Government announcement is of more than ordinary interest in the light of numerous recent declarations that the domestic oil supply is nearing exhaustion.

Three factors helped to bring this about: The increased output of the Gulf Coast area; the successful application of new recovery methods in the Appalachian field; and a gain in the production of the Rocky Mountain region which was generally supposed to be on the decline. Even so, 84 per cent. of the 1926 yield came from the mid-Continent and California fields.

Long Island Railroad Adds Oil-Electric Tugboat To Its Fleet

THE Long Island Railroad Company recently added to its New York Harbor fleet an oil-electric tugboat which embodies the latest developments in marine engineering for craft of this type. The boat—christened the *Meitowax*—is 108 feet long, 26 feet wide, and has a depth of 12¼ feet. Its power plant consists of two Ingersoll-Rand 6-cylinder, 4-cycle oil engines, each of 340 B.H.P. These engines are direct connected to Westinghouse 230-kw. generators and 25-kw. exciters. The 480-volt current thus generated drives the craft through a 565-S.H.P., double-armature, shunt - wound motor.

The "Meitowax"—the new tugboat of the Long Island Railroad Company. The generators that supply the electric driving power are actuated by two Ingersoll-Rand oil engines of 340 H.P. each.

Marked economy of operation is a feature of the boat. Test-performance records, covering a 24-hour day, show that the average daily fuel-oil cost of the *Meitowax* is approximately $45. This represents a saving of $111, as compared to the daily fuel bill of $156 attributed to a steam-driven tug of the same power. Despite the higher initial cost of an oil-electric tug and the higher interest charges that result, it is estimated that the yearly operating expense of a craft of this type is 20 per cent. lower than that of a steam-driven tug of equivalent power. This saving is sufficient to make up the difference in cost price within a few years.

In addition to economy of operation, the oil-electric tug possesses various other advantages. Among these may be cited convenience of control and flexibility of power application. The speed of the engines is held constant by the governor. The propulsion motor and rudder are controlled from the pilot house—resulting in greater ease of operation and greater safety in guiding the tug through traffic. Both the speed and the direction of rotation of the propulsion motor are controlled by a single lever; and the speed can be instantly changed from stop up to 115 revolutions per minute for either ahead or astern movement.

This flexibility is due to the fact that the oil engines run at a constant speed of 265 revolutions per minute, thus making always available their full power of which any desired amount can be applied to the propulsion motor.

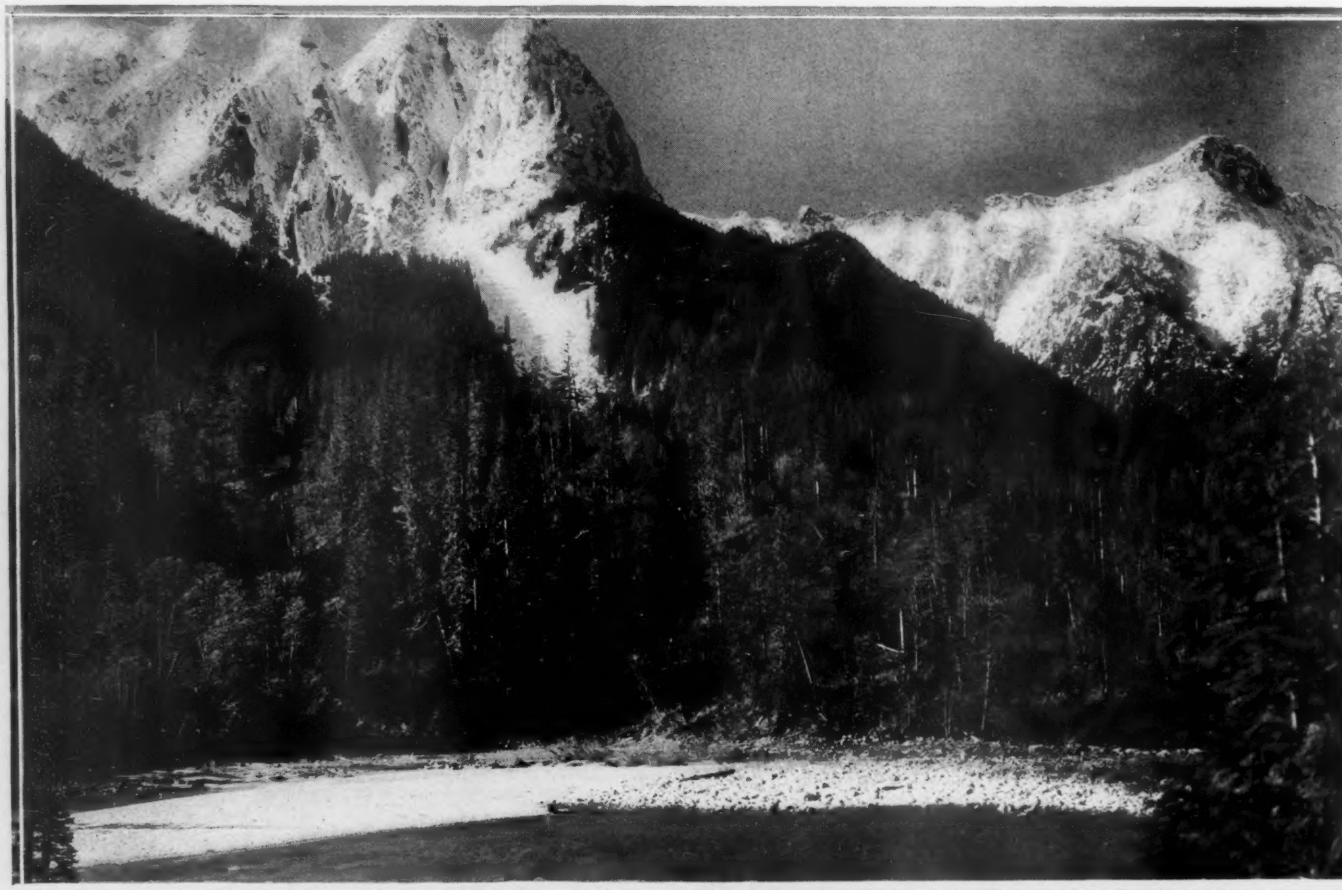
The oil engines are simple and accurate in action. The fuel oil is injected by two opposed spray nozzles into the combustion chamber, where it is thoroughly mixed with air drawn from the outside. This causes the formation of a homogeneous combustible that is productive of the greatest power efficiency and results in freedom from smoke.

The associate electrical equipment is designed especially for marine application. Power take-offs from the exciters, arranged through the various switchboard combinations, supply power to the motors which drive the engine-room auxiliaries. These auxiliaries include an Ingersoll-Rand Type 15 compressor for charging the air tanks from which the main engines are started. Two circulating - water and bilge pumps and a fuel-transfer pump also are provided. The steering motor, of 1½ H.P., operates at 550 revolutions per minute. A 4-kw., 120-volt, direct-current generator, driven by a Hill-Diesel engine rated at 6 H.P., supplies power and light for stand-by service. This power can also be utilized to run a 4½x5-inch compressor to furnish air for starting the main engines when no electrical energy is available.

As compared with other types of tugboats, the *Meitowax* and her class possess seven distinct points of superiority, as follows: Bridge control, constant-full-load power, excellent torque performance, economical generation of power, light weight of engine, savings in service time, and low operating costs.

The *Meitowax* was built at the plant of the Staten Island Shipbuilding Company and is similar in design to Tugboat *No. 34*, of the New York Central Lines, which was recently placed in commission in New York Harbor. Oil-electric tugs have been used for some time by the Atlantic Refining Company, which will shortly put in service three tankers with the same type of drive. Two oil-electric tugboats have been ordered by the Panama Canal Commission; and ferry boats, soon to ply the waters of San Francisco Bay, are to have oil-electric drive.

The steering wheel and all control levers of the "Meitowax" are conveniently placed in the pilot house, thus assuring ease of maneuvering and a greater measure of safety in handling the craft.



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Top—On the route of the Great Northern Railway west of the Cascade Tunnel. Mount Index and Mount Persis in their winter dress.

Bottom—Highway through a magnificent stand of virgin timber in the Cascade Mountains adjacent to the line of the Great Northern Railway.

Great Northern Railway Driving Long Tunnel Through Cascade Range

Concluding Description of Work at Mill Creek and at the East Portal

PART III

By ROBERT G. SKERRETT

BEFORE describing the methods of drilling and mucking employed at Mill Creek, it would probably be of interest to the reader to know how and with what care the tunnel line was carried down the shaft by the engineers and then projected east and west to guide the drill runners in their work. It was, of course, essential that the running of the line should be done with the utmost precision so as to insure the ultimate meeting of the headings advancing, respectively, east and west from the Scenic and the Berne ends of this great undertaking.

First, two 16-gage piano wires were dropped from opposite sides of the shaft—20 feet apart—and held parallel with the predetermined survey line. Each wire was weighted at the bottom with a 60-pound plumb bob; and at the top of the shaft each wire ran over a wheel that could be shifted laterally by adjustable screws so that the wire could be held true. The positions of the wires at the shaft mouth were checked by transit.

In order to prevent any swinging of the suspended wires, the plumb bobs were fitted with fins and immersed in tubs of water—the resistance thus offered serving effectually to keep the plumb bobs motionless. When everything was ready for the engineers to take their sights underground, all pumps and fans were stopped and hoisting was halted. These precautions prevented any disturbing vibrations or interfering air currents. So sensitive were the weighted 623-foot wires that a man climbing down the shaft ladder, when everything else was still, sufficed to impart enough motion to the bobs to be observable through the telescopes of the transits.

In taking the line from the plumb bobs, two oppositely placed transits were set up behind the wires and moved so as to bring the wires exactly in agreement on the true line. That is to say, each transit was brought in line with the two wires, and then the two instruments were trued to each other by focussing them on their respective eyepiece. It should be self-evident that these exacting precautions were thoroughly justified. It is interesting to recall that at a point 1,200 feet west of the shaft the tunnel will have approximately 3,700 feet of ground above it.

The transporting of all materials up and down by way of the shaft is a big item in the daily work. In the course of 24 hours, ap-

Top, left—Loading a car with drill steels at the East Portal. Right—East Portal of the main tunnel before the removal of the bench.
Bottom, left—Equipping a Marion air-driven shovel with caterpillars preparatory to the removal of the bench in the main tunnel at the East Portal. Right—The drill doctor at the East Portal who sees to it that the R-72 drifters are kept fit for their exacting work.
Center—Frank J. Kane, superintendent at Mill Creek.

Left—Looking down Nason Creek with the East Portal of the new tunnel at the right and the present line of the Great Northern Railway at the left of the picture.
Right—At the East Portal. The bridge to the left, over Nason Creek, is the way by which tunnel muck is carried to the fill for the relocated section of the railroad line.

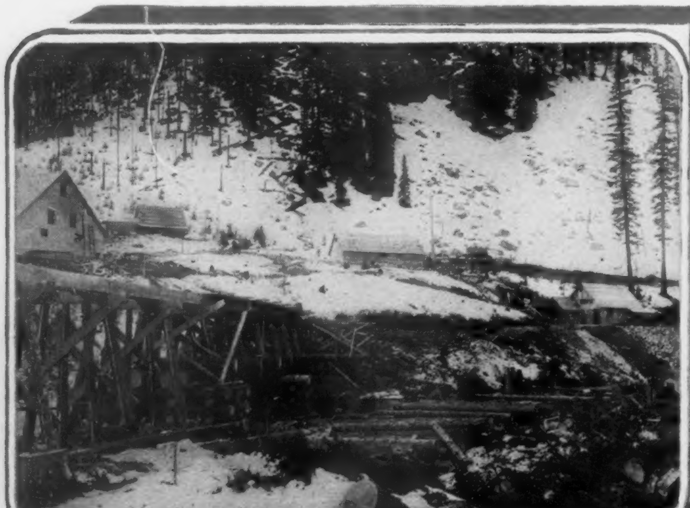
proximately 1,500 steels are moved in both directions; and then there is the similar handling of piping, rails, ties, drills, etc.—all this additional to the rock brought to the surface and to the lifting and lowering of the men engaged underground. To facilitate the ready overhauling of the drills, a drill shop is maintained underground.

At Mill Creek the main tunnel is being driven full size west from the shaft; and 42 holes are used in the top heading and 46 holes on the bench. All holes, both in the bench and the heading are drilled to a depth of 14 feet; and the drifting is being done with Ingersoll-Rand R-72's. Mr. Frank J. Kane, the superintendent at Mill Creek, found it necessary to abandon vertical holes and to use only horizontal holes in drilling the bench—employing 46 holes as just mentioned. When using vertical holes, the sizes of the chunks were too large to go through the grizzly in the shaft hopper. Even now it is frequently necessary to blockhole some of the large pieces or to shatter them with paving breakers.

In driving the top heading on the full-size-tunnel section four drills are employed mounted on two upright 4-inch bars. Four machines are also used on the bench, but they are set up on a 4-inch crossbar, 18 to 20 feet long, which is supported in the middle by a column arm. In shooting the bench, 1½-inch sticks of 80 per cent. dynamite are employed so as to break up the rock as much as possible. Sixty per cent. dynamite is used in all headings.

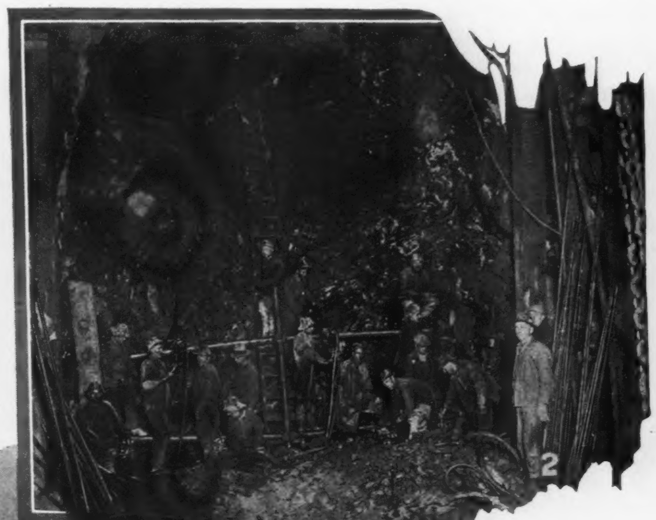
At the 10x10-foot center heading, going east on the railroad-tunnel line from the Mill Creek Shaft, the four drifters employed are set up on two 4-inch columns—two machines on each bar. The drill round generally used at Mill Creek is what is commonly described as a diamond cut or a modification of it, altered to suit conditions. A set-up of two 4-inch columns, with two drills on each bar, is the practice also in the pioneer-tunnel heading. In the pioneer tunnel, a drill round consists of 28 holes; and in the 10x10-foot center heading—going eastward on the main-tunnel line, 32 holes are drilled per round. The center holes are 13 feet in depth while the side holes are 11 feet in depth.

A 20-ton, air-operated Marion shovel does the mucking at the main-tunnel bench. The smaller Marion shovel was chosen for work at Mill Creek because its parts could be sent down through the shaft for assembly underground. A "Little Tugger" hoist, set on top of this shovel, operates a scraper in clearing off some of the dirt at the top of the muck pile after a blast. This hastens the rigging up of drills for the resumption of work. The "Little Tugger" hoist is also used to handle the 12x12-inch posts in getting them into position wherever timbering is necessary in the enlarged tunnel section. Of the first 500 feet of full-size railroad tunnel finished at Mill Creek only 150 feet needed to be timbered. Muck at the main-tunnel bench is loaded into 6-yard, side-dump cars, and hauled to the dump by



© Pickett Photo Company.

Left—Looking across Nason Creek toward the East Portal.
Right—Part of the camp at the East Portal. Present line of the railroad is seen at the right in the middle distance.

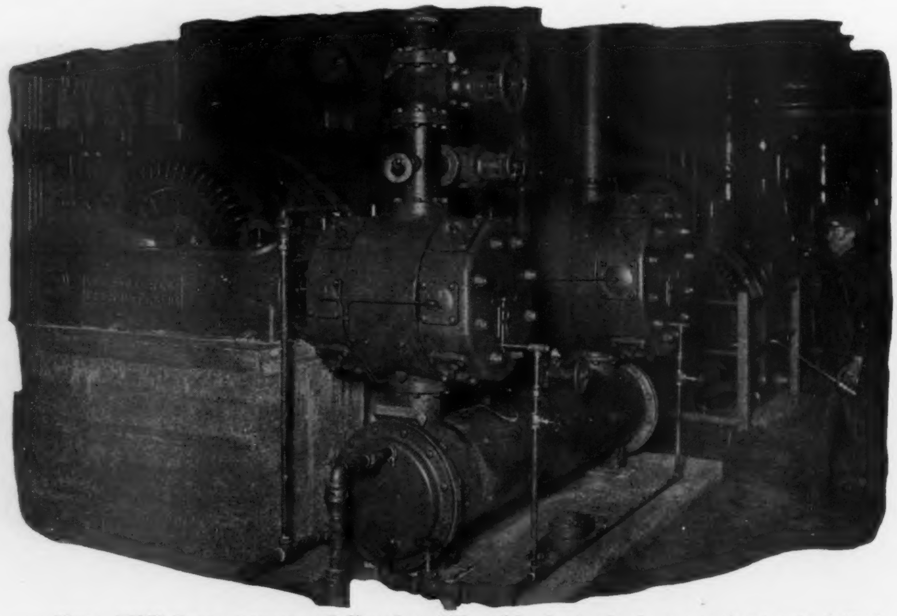


Pickett Photo Company.

1—Drilling lifters with R-72 drifters at the heading being driven westward from the East Portal.
2—Drilling lifters with R-72 drifters in main-tunnel heading at Mill Creek.
3—Some of the men to whom honor is due for making a world record at the East Portal in driving 984 feet of 10x10-foot tunnel. From right to left: Engineer T. E. Downey; Captain C. G. Jones, superintendent; Tom Halkyard, shifter; Jim Justice, walking boss; John Carr, shifter; Tommy McDermott, shifter; and W. H. Erickson, timekeeper.
4—Ready to drill lifters with R-72 drifters in the center heading at the East Portal.
5—A group of Ingersoll-Rand drifters at the heading being driven eastward from the Mill Creek Shaft.

10-ton General Electric locomotives using trolleys.

In going downgrade in the workings west of the shaft, a portable crossover is employed to shift the mucking cars from the waiting to the loading track at the pioneer heading. Eastward, on the rising grade, the shifting at the center heading is done by an air-operated car transfer—a "cherry picker," such as has already been described as in use at the West Portal. The cars handled in this way are of 2-yard capacity. Six-ton General Electric locomotives do the hauling of the muck cars at the pioneer and the center headings.



Type XRE-2 compressor, delivering 980 cubic feet of air per minute, installed at the Mill Creek Camp.

Operations at the East Portal are supervised by Captain C. G. Jones, who has been identified with a number of large railroad construction jobs. The method of procedure at the East Portal has differed from that at Mill Creek and the West Portal because the object is, as far as practicable, to drive a single center heading and then to ring shoot to full size only after the 10x10-foot heading has been holed through with the corresponding heading coming east from Mill Creek.

Owing to the nature of the ground at the site of the East Portal, it was found undesirable to start work there with a center heading. Accordingly, operations were begun by driving an adit 90 feet to the North of the East Portal site and then advancing it on a curve for a distance of 193 feet until that heading met the line of the main tunnel. This procedure saved considerable time and made it possible to start tunneling at the East Portal on February 8, 1926. Air for this work was furnished by six I-R portable compressors, four of which were arranged in tandem and formed a single battery. These compressors continued in service until the regular power plant was ready to take over the load. This power plant consists of three 950-foot, 2-stage, motor-driven compressors delivering 2,850 feet of air per minute. In the compressor house there are also motor-generator sets which produce direct current of 250 volts for use in lighting the camp and the tunnel and for hauling operations.

From the point of intersection of the adit and the main-tunnel line a top heading was driven eastward to the portal, winged out, and timbered to full size. The bench had not been touched at the end of last November, when the writer visited the tunnel; but preparations were in progress to do so—a 40-ton, air-operated Marion shovel then being placed upon caterpillars in readiness to handle the muck at that point. At that time the center heading had penetrated 6,724 feet.

It should be recalled that Captain Jones' men, during the month of September, 1926, made a world's record in driving a 10x10-foot center heading a distance of 984 feet in 31 days—the greatest progress being 43 feet in 24 hours! The daily details of this progress are given in an accompanying tabular statement. This achievement represented the drilling, shooting, and mucking of 3,644.4 cubic yards of solid rock. With such a performance to the credit of the men at the East Portal, there is every reason to believe that an enlargement record of 1,200 feet a month will be practicable when that work is taken in hand as soon as the center heading from Mill Creek meets the corresponding heading being driven westward from the East Portal.

Steels are changed every 25-26 inches; and the holes are drilled to a depth of 12 feet. An average advance of 10 feet is made at each shot. All drilling at the center heading is done on a horizontal, 4½-inch bar mounting for R-72 drifters; and a round consists usually of 30 holes. All but 5 or 7 holes are drilled above the bar, with the bar remaining as first placed above the muck pile and with the men standing on the muck pile.

Captain Jones is satisfied that he can make better time with a bar than with a drill carriage; and he thus describes the cycle of operations at a heading following a shot. "After shooting, we allow half an hour to clear the air at the heading, and then about 20 minutes are required to bar down loose rock to make the heading safe to return to it for drilling. During the interval some mucking is done where dirt is up against the face; and at the same time the bar, four drills, and an average of 160 steels are brought up. Finally, the set-up is made and the drills are ready for work—the entire preparations taking commonly 1½ hours.

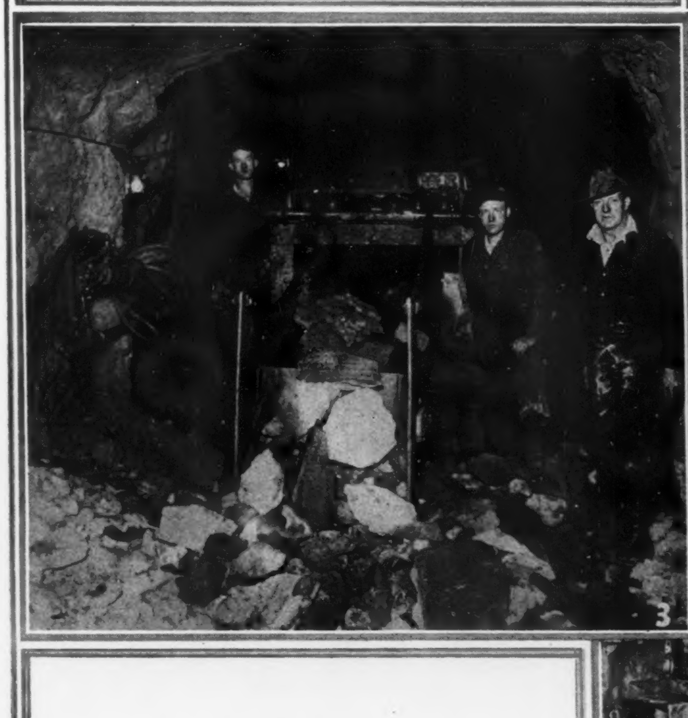
"The drillers stand right on the muck pile. Mucking begins where the 'fly rock' lies—sometimes 200 feet from the heading, and goes on toward the face. By the time the shovel loader is close up and ready to dig into the last of the pile, the drillers have finished all but the 5 or 7 holes at the bottom. It takes from 15 to 20 minutes to complete the mucking; and as soon as this is done the bar is set up within a foot of the bottom of the face, four drills are mounted upon it—the time for this averaging 15 minutes, and the bottom holes are drilled. While these holes are being drilled the muckers do the track work, and dynamite is brought in. As soon as drilling is completed at the bottom of the face—generally in half an hour

Pickett Photo Company.
Blower station and ventilating ducts one mile in from the East Portal.

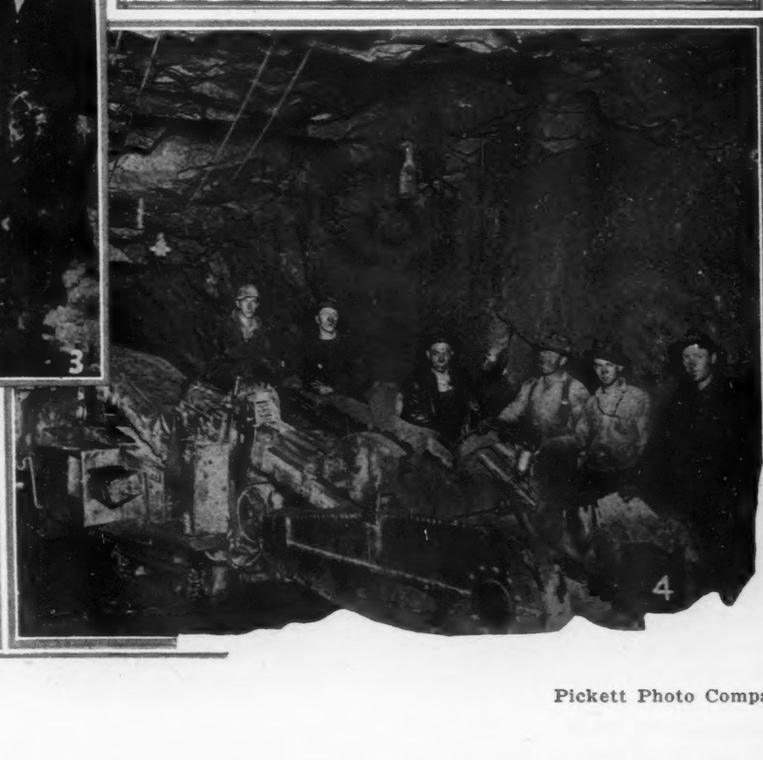
SOME OF THE MUCKING MACHINES USED IN DRIVING THE CASCADE TUNNEL

2—"The graveyard lunch," at Berne, as the men jocosely call the car that brings food in to them so that they do not have to leave the tunnel during a shift.

1—An air-operated Marion shovel mucking in the main-tunnel section going westward from the Mill Creek Shaft.



3—A Conway mucking machine at the 10x10-foot heading being driven westward from the East Portal.



4—One of the Myers-Whaley mucking machines in the West Portal section of the tunnel.

Pickett Photo Company.

Pickett Photo Company.
One of the pleasant social sides of life in the camps. A dance in the hotel at Scenic.

—the holes are loaded, and everything is cleaned up for a shot.

"What we do is this: We manage to pick up a round in the course of 48 hours by the cycle of operations used at the East Portal—work, as you know, going on day and night without a halt, week in and week out. We count, of course, on three rounds a day, and try to make or save enough time to gain an extra round every two days. My men are just as keen as I am to do this."

It should be realized that where a drill carciage is used at a heading it is necessary to complete the mucking right up to the face before the carriage can be put in position to resume drilling. This explains the difference in time elapsing between shooting and the resumption of drilling when the carriage and not the bar is used for a set-up.

Mucking at the East Portal is done by a Myers-Whaley machine loading into Koppel 2-yard side-dump cars. The cars are hauled by General Electric 6-ton locomotives, such as have been described previously. Also, the 2-foot-gage track is arranged as in the other tunnel headings; but there is a notable difference in the means employed to shift the cars from the waiting track to a position on the other track at the rear of the shovel loader. A portable crossover is used for this purpose, and it is as effective as it is simple.

The crossover was made by the blacksmith at the East Portal out of 1½-inch square steel. It is in two parts, suitably cross-braced, with the ends bent over to grip the rails on which it is laid. The two parts are held together by a pin; and the half that is shifted to complete the union between the two tracks is easily and quickly handled by two men. By means of this portable and light crossover, cars can be speedily shunted from the stand-by to the loading position. The contrivance is one more evidence of the many efforts that are being made to save seconds in a ceaseless endeavor to complete the tunnel in the amazingly short period of three years, from start to finish!

The rock encountered at the East Portal has required no timbering. Between February 8, when tunneling was started, and November 22, 1926, the men under Captain Jones achieved a total penetration of 6,724 feet. This performance is evidence of splendid teamwork, fine spirit, and an unfaltering determination to make good on the job.

The means and the method of ventilating the tunnel work at the East Portal are the same as those relied upon at the other camps, and are equally effective and satisfactory. Occasional pockets of water have been struck as the heading advanced westward, but none of these has caused more than brief trouble; and the air-operated pumps installed have been able to dispose promptly of the seepage.

In addition to the tunnel work, itself, operations at the East Portal have included 4,800 lineal feet of line change between the portal site and where the new line will join the existing tracks of the Great Northern eastward of Berne in Nason Creek Valley. This relocation work has called for the removal of much rock; and in doing this "Jackhamers" of Model DCR-23 have been utilized.

So much for the various methods of operating at the three camps. Now let us touch upon some features in connection with this great undertaking that are common to all the camps and that show how carefully the contractor has planned for the well-being of his personnel and how it is possible for him to obtain the astonishing results he has achieved so far.

Mr. W. E. Conroy, assistant general superintendent for A. Guthrie & Company, Inc., has thus spoken of the men on the work: "I have never been on a job where the morale is as high as it is here; it is marvelous! The nature of the task and the character of the undertaking have attracted a high class of men, and the results prove it."

Naturally, there must be some material reason, too, for this, and the explanation is the bonus system adopted which is the urge to what might properly be described as super-performance. First, attractive rates of pay are offered all men composing the mucking and drilling crews, and this compensation holds up to a monthly advance of 650 feet in any heading. A bonus is paid for all footage beyond that during any month; and it is the winning of this extra compensation that inspires the crews to do their utmost.

There is keen but friendly rivalry among the several crews and between the different camps; and up to the present this competition has been most marked between the men at the East and the West Portals. Aside from the monetary reward for excellence, the winning camp has the right to fly a pennant carrying the symbol of the Great Northern Railway—a Rocky Mountain Goat. Therefore, "to get the other

Flag-raising ceremony at the Berne Camp when an East Portal crew won the progress record by driving 984 feet of 10x10-foot tunnel in the course of 31 days.


Left—The road from Berne to the East Portal Camp as it appeared in November.
Right—At the East Portal. A heavy freight train in the middle distance climbing the grade near Berne.

fellow's goat" is the aim of each competitor in this contest, which has for its end the piercing of the Cascade Range in the shortest possible time.

Perhaps the spirit of this struggle can be made clearer by recalling what happened when the East Portal crews drove the 984 feet of 10x10-foot heading during September of last year. When Captain Jones telephoned the news to his fellow superintendent at the West Portal—then Mr. Otto C. Hartman—the Captain said: "You can send the pole with the flag, you won't need it again; and I am sending you a bag of cement to fill the hole!" However, fortune again smiled upon the labors of the men at the West Portal, and the following month the pennant went back to that end of the undertaking.

All told, there are nearly 1,000 workers connected with the tunnel operations at the three camps; and, besides, there is an office and camp administration force of 150, not the least important of which are the cooks that prepare the good and abundant food that is served in the different mess halls. The unmarried men are quartered in comfortable bunkhouses, while there are substantially 90 dwellings for men with families. The family houses have from three to four rooms with bath, have modern plumbing, and are lighted with electricity. They rent for from $15 to $20 a month.

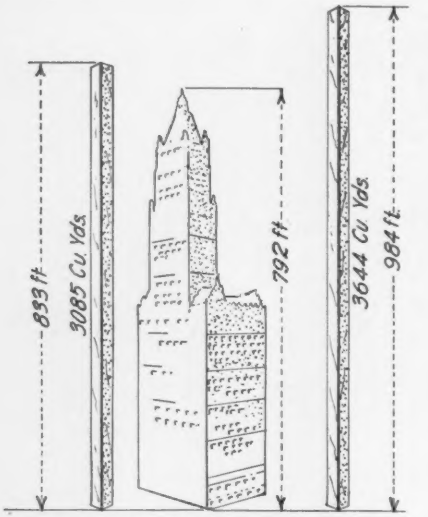
Water is obtained for the camps from indisputably pure mountain springs or streams, and is carried to the camps and distributed there through wood-stave pipes. There is a regular sewage system at each camp suitably connected with septic tanks. In short, everything within reason has been done by the contractor to safeguard the health of the people in the three camps; and the sanitary arrangements and the general conditions at those places have won the commendation of competent health authorities. Hospital facilities have been provided at each of the camps; but, fortunately, there have been but few occasions so far when their services were needed for serious cases. There is a resident physician at each camp. At both portals and at Mill Creek there are change and dry rooms, with steel lockers, where the men can enjoy either hot or cold baths and can shift their clothes when going on or coming off work.

DRIFTING RECORD MADE AT EAST PORTAL DURING SEPTEMBER, 1926

Date		Time of Shooting				Progress	
						Daily	Total
Sept.	1	8:00 a.m.	3.30 p.m.	12:15 a.m.	....	25	25
	2	8:50 "	3:25 "	11:30 p.m.	7:00 a.m.	37	62
	3	3:10 p.m.	11:55 "	....	....	16	78
	4	8:50 a.m.	3:40 "	12:00 m.	7:25 "	34	112
	5	3:05 p.m.	11:15 "	6:50 a.m.	....	29	141
	6	2:45 "	11:20 "	7:15 "	....	29	170
	7	3:35 "	11:15 "	6:30 "	....	29	199
	8	2:50 "	11:00 "	7:00 "	....	29	228
	9	2:20 "	9:45 "	4:55 "	....	29	257
	10	11:10 a.m.	6:25 "	1:55 "	....	29	286
	11	8:50 "	5:45 "	12:40 "	....	29	315
	12	8:20 "	3:20 "	10:35 p.m.	7:00 "	42	357
	13	3:35 p.m.	11:10 "	7:10 a.m.	....	29	386
	14	3:10 "	10:15 "	5:25 "	....	27	413
	15	12:55 "	8:50 "	3:35 "	....	28	441
	16	9:50 a.m.	3:55 "	11:25 p.m.	6.40 "	38	479
	17	1:55 p.m.	8:45 "	4:25 a.m.	....	30	509
	18	10:50 a.m.	5:10 "	11:20 p.m.	5:55 "	43	552
	19	11:55 "	6:25 "	2:55 a.m.	....	26	578
	20	9:05 "	4:30 "	11:45 p.m.	6:30 "	35	613
	21	1:00 p.m.	7:20 "	1:30 a.m.	....	30	643
	22	8:00 a.m.	3:45 "	11:10 p.m.	5:50 "	38	681
	23	1:15 p.m.	7:20 "	2:05 a.m.	....	26	707
	24	8:30 a.m.	2:55 "	9:20 p.m.	4:05 "	37	744
	25	10:45 "	4:55 "	12:10 a.m.	7:00 "	36	780
	26	1:45 p.m.	8:15 "	3:35 "	....	30	810
	27	10:00 a.m.	3:50 "	10:35 p.m.	5:50 "	39	849
	28	11:50 "	7:05 "	12:55 a.m.	7:10 "	37	886
	29	1:50 p.m.	8:55 "	3:50 "	....	29	915
	30	10:10 a.m.	4:25 "	10:50 p.m.	5:10 "	39	954
Oct.	1	12:30 p.m.	7:55 "	3:45 a.m.	....	30	984

Pickett Photo Company.

Sunset Falls on the picturesque Skykomish River along which the Great Northern Railroad runs to and from Stevens Pass.



A graphic story of the amounts of rock drilled and mucked during two periods of 31 days when the East Portal and the West Portal, respectively, made drifting records that startled the engineering world.

Of necessity, the camps are self-contained communities. Besides commissary stores, each camp has a schoolhouse and a teacher for the resident children, and a recreation hall—properly equipped—where the men in their off hours can find books to read or other forms of diversion and where, just once so often, all hands see a movie show or enjoy themselves dancing. Because of all these things done by A. Guthrie & Company, Inc., for the contentment, the welfare, and the enjoyment of the people at the several camps, the labor turnover has been exceptionally low compared with that of similar undertakings elsewhere.

No small measure of the success of the work up to date is due to the administrative skill of Mr. R. F. Hoffmark, general superintendent, upon whose shoulders rested the primary burden of organizing the field force and the operative material. The project is under the general direction of Mr. J. R. W. Davis, chief engineer, Great Northern Railway, St. Paul, Minn., for the railroad company, and of Mr. J. C. Baxter, vice-president of A. Guthrie & Company, Inc., St. Paul, Minn., for the contractor.

In conclusion, the writer wishes to express his appreciation of the help given him by Colonel F. Mears, Mr. M. J. C. Andrews, resident engineer for the railroad company, Mr. R. F. Hoffmark, Mr. W. E. Conroy, Mr. Frank J. Kane, and Captain C. G. Jones in gathering the material for this article and in passing upon the text after it was written.

PROGRESS AT VARIOUS TUNNEL HEADINGS

	November	December	January	February
Scenic pioneer heading—eastward	952 ft.	819 ft.	844 ft.	579 ft.
Scenic center heading—eastward	942 "	892 "	1274 " *	1215 " *
Scenic enlargement—eastward	...	...	...	700 "
Berne center heading—westward	938 "	865 "	845 "	723 "
Mill Creek center heading—eastward	648 "	793 "	765 "	...
Mill Creek center heading—westward	...	...	...	17 "
Mill Creek pioneer heading—westward ...	620 "	745 "	752 "	708 "
Mill Creek from Crosscuts Nos. 1 and 2—westward	...	...	...	649 "
Mill Creek full tunnel—westward	200 "	219 "	244 "	92 "

*Drilling and mucking alternately in different headings.

GOVERNMENT AIMS TO MAKE TARNISH-PROOF SILVER

WITH a view to increasing the uses of silver, and thereby improving the status of the silver-producing industry of the United States, the Bureau of Mines is conducting exhaustive experiments in an effort to discover an alloy high in silver content that will not tarnish. According to a recent report, no alloy has yet been found that is entirely tarnish-proof, but several have been developed that are more resistant to this action than is sterling silver.

It has been determined that alloys of cadmium and silver and of zinc and silver are highly resistant to tarnish, but they have the lowest tensile strengths of any of the alloys studied. The addition of either antimony or tin, or both, to a silver-zinc alloy—the sum of all the alloying elements being kept below 7.5 per cent. in order to give an alloy of sterling fineness—produced workable alloys that are markedly tarnish-proof and that have the desired strength.

It has been learned that alloys of silver containing 15 or 20 per cent. of zinc or of cadmium and 20 per cent. of gold, and which are very easily worked, not only possess strength and hardness values more closely approaching those of sterling silver than do any of the other alloys prepared but, at the same time, offer great resistance to tarnish. An alloy of silver with 20 per cent. of zinc, with sufficient gold added to make the intrinsic value equal to that of sterling silver, reveals approximately the same degree of tarnish resistance as does the silver-zinc or silver-cadmium alloy with a high gold content.

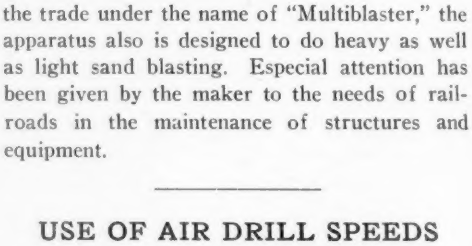
HEAT-RESISTANT WHITEWASH

SUBSTANTIALLY all industrial plants have need of a surface coating that will withstand temperatures above those which destroy ordinary oil paints. Large numbers of such coatings have been recommended, but objections have been found to most of them on the score of cost, light effect, durability, etc.

The refractory properties of lime and the whiteness of the film obtainable with whitewash led to a study of the possibility of adapting it for use on surfaces subject to high temperatures. Very satisfactory results have been obtained; and formulas have been developed that produce films which are standing up well after months of exposure under severe conditions. There is a wide field of application for high-temperature whitewashes; and industrial chemists should be interested in the details of the investigations conducted by the National Lime Association.

SPECIAL NOZZLE HAS DUAL FIELD OF SERVICE

THE firm of George M. Stowe, Jr., of Buffalo, N. Y., manufactures a plunger-nozzle type of paint spray for which are claimed marked operating economies. It is made in three sizes for work requiring careful application and for the covering of broad surfaces. It is declared that with the type of spray nozzle suitable for the heavier class of work it is possible to coat 600 square feet of surface with one gallon of paint and that an operator can cover 3,000 square feet in an hour. Known to the trade under the name of "Multiblaster," the apparatus also is designed to do heavy as well as light sand blasting. Especial attention has been given by the maker to the needs of railroads in the maintenance of structures and equipment.



Nozzles of this type are made for sand blasting as well as for spray painting.

USE OF AIR DRILL SPEEDS UP MILLING OPERATION

THE following letter from E. P. Stoutenger, of Syracuse, N. Y., which was published in *Machinery,* is reprinted for the benefit of those of our readers who may be confronted with similar problems.

"From floor to floor, the time consumed in facing four flanges on four sides of a casting has been cut from about 10 minutes to 1½ minutes by operating the hand feed by means of an air drill. The machine, a plain miller, was equipped with an inserted-tooth cutter, mounted on the end of the spindle—the arbor supports and the brace being removed. A turret-type fixture, revolving in a horizontal plane and indexing around a point equidistant from all four faces, was clamped to the table. This set-up was very satisfactory, with the exception of the production time. As the table traveled a considerable distance and had to be reversed, indexed, and fed through four times by hand, the time required was considered excessive.

"A highly satisfactory solution of this problem was found in the application of an air drive to the lead-screw. A suitable casting was made and machined to provide a support for a stock air drill on the end of the table. This casting also housed the drive from the air drill to the lead-screw. This simple arrangement allows the operator to obtain the utmost from his machine, as he can, by a slight twist of the air drill, vary the speed at the completion of the cut from a slow-cutting speed ahead to full speed reverse."

Work Goes Forward on Subway Systems of Greater New York

MEASURED by the monetary activities of the Board of Transportation, the citizens of the City of New York have every reason to look forward confidently to relief when occasion calls for either hastening to the office in the morning or speeding homeward at the close of the day's work.

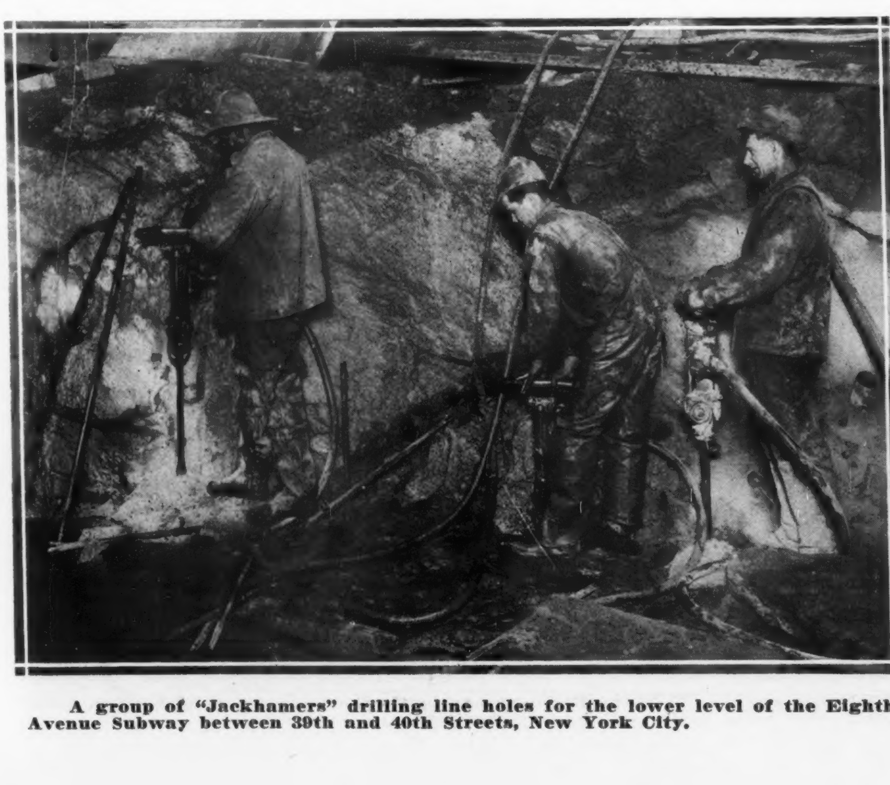
During the twelvemonth of 1926, the Board of Transportation received proposals for construction work totaling $75,773,149. These proposals had to do with subway sections that will contain approximately 21 miles of tracks; and awards made for the work in hand aggregated a money value of $55,563,737—contracts that give employment to a matter of 10,000 men.

Since the Board of Transportation was called into being a little more than two and one-half years ago, the organization has laid out, planned in detail, and awarded contracts calling for a combined expenditure of $150,324,214. This immense sum covers disbursements in connection with 17 route miles of rapid-transit construction.

Drilling a bench in the cut of the Eighth Avenue Subway at 40th Street with "Jackhamers."

At the present time, the daily average number of contractors' employees engaged on rapid-transit work of this sort is 9,761. Of this number, 7,836 are engaged in the construction of the city's new subway system; 353 are at work on the Interborough Rapid Transit system; and a total of 1,572 are employed on the Brooklyn-Manhattan Transit system.

The awards made last year in connection with subway building operations in the Borough of Manhattan totaled $47,736,576, and embraced eight major contracts. There are now under contract 25 sections of the city's new subway system—covering sections at Washington Heights, Central Park West, Eighth Avenue, Sixth Avenue, and Church Street—that represent the obligating of $118,821,252. These sections have to do with the main trunk of the subway system, from which branches will spread out under the Harlem River to the Bronx, and under the East River at 53rd Street, at Rutgers Street, and at Fulton Street to the boroughs of Brooklyn and Queens.



A group of "Jackhamers" drilling line holes for the lower level of the Eighth Avenue Subway between 39th and 40th Streets, New York City.

By lengthening the platforms of 40 stations on the Brooklyn-Manhattan Transit system in Brooklyn and in Manhattan it will be possible to accommodate 8-car trains, and this increase in the length of the trains will increase the passenger-carrying capacity of each of the trains by 33⅓ per cent. This substantial betterment will call for an expenditure of $743,498.

Because of the unit magnitude of the Eighth Avenue Subway now in course of construction, this great engineering task has to a large extent overshadowed the other and also essential undertakings in hand under the supervision of the Board of Transportation. To detail these various and comparatively minor projects might weary the reader, but several of these are big jobs, and each in its way will do its share in adding to the scope of the subway system of Greater New York and contribute proportionately to the convenience of the public and to the upbuilding of those parts of the Metropolis that will be tapped by them.

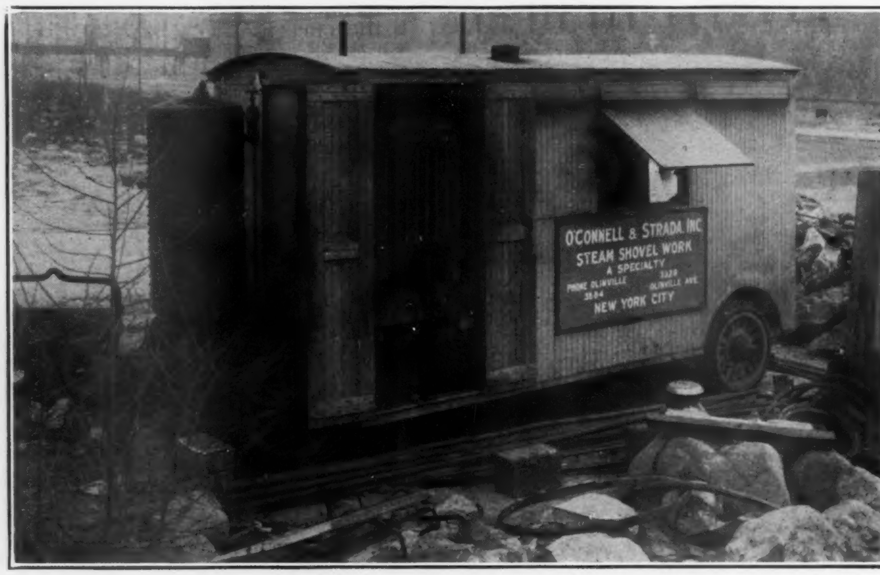
Contract drawings for the connection at Fulton Street, Manhattan, and Cranberry Street, Brooklyn—passing under the East River—are substantially finished and ready for advertising; and the Board hopes to be in a position in the near future to award contracts for the construction of the 53rd Street route under Welfare Island to Long Island City, where the Brooklyn and the Queens lines will join. This link in the system will involve a sum of $20,209,412.

During 1926, the Board acquired 176 parcels of real estate in the boroughs of Manhattan, Brooklyn, and the Bronx having a combined area of about 43 acres. The total value of the rights in real property so acquired is approximately $10,500,000.

Big as the foregoing figures are, still, in the end, they will be amply warranted if the outlays prove effective in providing rapid-transit relief, which is undoubtedly needed now and for which the demand will grow directly as the population of the City of Greater New York is augmented from year to year.

In this indispensable work of subway extension, various mechanical facilities are hastening the completion of the different jobs involved; and in these vast undertakings compressed air, air-driven rock drills, and other pneumatic tools and agencies are performing helpful services.

It is proposed by the erection of seven barrages to make the cataract region of the River Kongo above Matadi navigable for large ocean-going steamers and, at the same time, to utilize the falling waters for the production of electricity. Each barrage or dam would take about four years to build. While the project is an ambitious one, still it is believed that the outlay would be justified in view of the potential wealth of the Belgian Kongo. Moreover, all railroad construction in the region offers well-nigh insurmountable difficulties.



Portable blacksmith shop that has proved very satisfactory to the enterprising contractors that called it into being.

Mr. A. T. Galbraith, vice-president and general manager of sales of the Crucible Steel Company of America, has announced the development by that company of a new steel that is said to be twice as strong as ordinary steel. The new product is known as H Y C C. While it was first made in the laboratories of the Crucible Steel Company some years ago, its production on a commercial scale was delayed owing to the difficulty of finding suitable alloys. This handicap has now been overcome.

PORTABLE BLACKSMITH SHOP AND COMPRESSOR PLANT

A COMBINED compressor plant and blacksmith shop on wheels, which has proved a valuable piece of equipment on rock-excavating contracts in upper New York City, is shown in the accompanying illustrations. It consists of a compact wooden structure mounted on a truck chassis, rendering it easily and quickly portable from job to job. This mobile plant houses a 10x8-inch Type Twenty portable compressor, a No. 33 "Leyner" sharpener, a forge, an anvil, and the necessary smaller accessories of a blacksmith shop. A motor truck is used to tow the outfit.

As the unit is completely assembled, preliminary labor incident to set-ups at new working stations is reduced to a minimum. In fact, experience has shown that the entire plant can be put in operation in about ten minutes. It can be readily moved from place to place on a job as work progresses, thus always assuring accessibility to the drilling sites. Furthermore, it furnishes protection for the blacksmithing crew regardless of weather conditions, and can be closed and locked at night.

The particular outfit shown has been in almost continuous service for the past four years, and has been employed principally on excavation work for large apartment houses. In addition to furnishing power for the pneumatic sharpener, which ordinarily reconditions the steels for from 6 to 10 drills, the compressor supplies air for DCR-23 "Jackhamers" using 1-inch steels.

The structure was built and equipped by the firm of O'Connell and Strada, Inc., now disbanded, which consisted of James O'Connell and Charles L. Strada. Each of these men now heads his own company. The original plant is in the possession of Mr. O'Connell, while Mr. Strada has had constructed for his own use two such portable blacksmith shops and compressor plants. These new structures are like the earlier model except for the superstructure, which is of metal instead of wood. Both of the contractors have expressed themselves as highly pleased with the outfits, and have found that they meet their requirements in the field in a very satisfactory manner.

Forge and No. 33 "Leyner" sharpener in the portable blacksmith shop, with compressor plant in the adjacent compartment.

TURNING A WASTE PRODUCT INTO PAPER

THE year 1927 is expected to see the inauguration of papermaking in Alberta, not, as might be expected, from the province's stands of poplar and jackpine but from grain straw. Both the Alberta and the Canadian governments have been investigating the Bache-Wiig process that utilizes grain straws in the manufacture of paper; and, as a result of experiments, those interested are satisfied that the process has great commercial possibilities in Alberta.

A plant is being built in Edmonton, and is expected to start production some time this year. If entirely successful, this plant is to be the first of a chain running through the agricultural districts of the province. Wrapping paper, cardboard, and other coarse paper are to be manufactured at the outset. Later, attention will be given to newsprint.

A huge dirigible has been planned by British interests that will be capable of carrying 100 passengers with their baggage and 10 tons of mail. The *R-101*, as the airship is to be known, will have a gross lifting capacity of about 150 tons, a length from nose to rudder of 730 feet, and a maximum beam of 132 feet. Her five heavy-oil engines, of 600 H. P. each, will give the craft a speed of 70 miles an hour at an altitude of 5,000 feet; and she will have a cruising radius, without refueling, of 4,000 miles.

Strengthening Power Dams in the Alps

By G. COLLINO

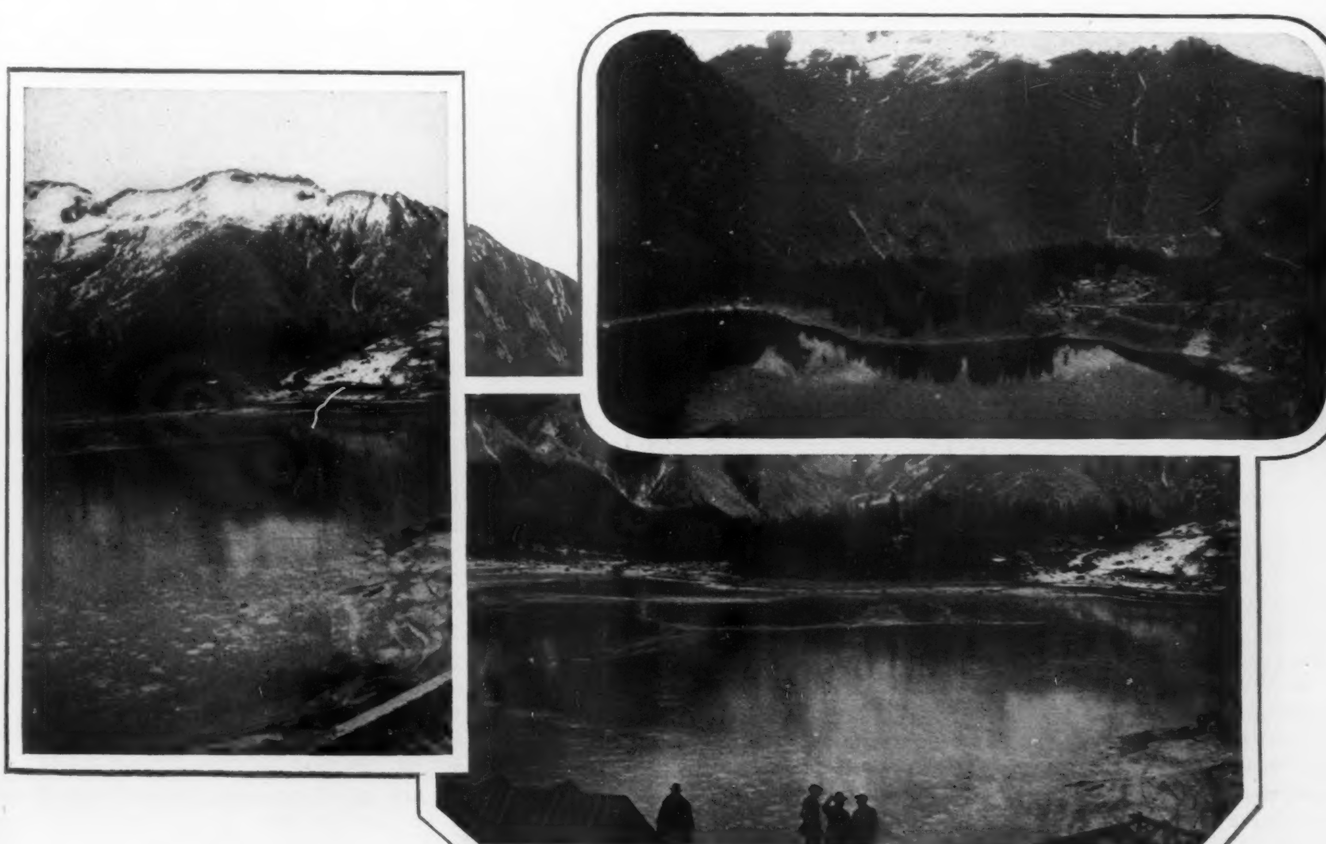
ITALY has been doing engineering wonders in recent years in the way of erecting magnificent dams and impounding large volumes of water to operate the turbines of big hydro-electric stations. In this skillful utilization of natural sources of power, the Italian engineers have made the most of the waters flowing southward from the precipitous slopes of the Alps where the descending waters, in the course of ages, have cut deep channels in the bottoms of narrow valleys having steep sides. In this manner, it has been found possible to conserve measurably the waters of spring floods produced by the melting snows far above on the mountains and also to regulate and to put to effective service the stream flows throughout other seasons of the year.

By thus harnessing the energy in these mountain streams, the Italian engineers have been able to offset to a considerable degree Italy's handicap in the matter of a lack of domestic coal deposits. Not only that, but by this conversion of water power into electric current it has been made practicable to furnish large blocks of motive energy to certain industrial centers in northern Italy. Among these manufacturing focal points is the City of Milan; and, in particular, Milan obtains a considerable percentage of her electric current from power stations situated in some of the valleys on the southern slopes of the Bergamasker Alps.

Before coming to the purpose of this article, it might be of interest to mention the fact that the demand for hydro-electric power in Italy has been steadily on the increase; and, according to the latest authoritative figures, current consumption in Italy in 1926 was approximately 18 per cent. higher than it was during the year preceding. There are at present in Italy 86 large power reservoirs having a combined impounding capacity of 1,047,000,000 cubic yards. This total will be augmented by substantially 2,050,000 cubic yards of stored water when certain reservoirs now under construction are completed.

The creation of some of these reservoirs has taxed the technical resourcefulness of the engineers; but, generally speaking, these experts have been equal to the demands made upon them. Even so, time alone is occasionally the only sure index of success, because water is extremely penetrating and searching in its action—especially when responding to the pressures developed by high heads. That is to say, the water may gradually and insidiously undermine and loosen the foundations of seemingly secure and certainly massive structures. Once a dam has been endangered in this manner, there is no telling what may happen or when it may happen if the weakness be not discovered and corrected without delay. It was just such an unforeseen catastrophe that has led the Italian engineers to take steps to forestall similar disasters not only in the cases of dams already built but where dams are today in course of construction.

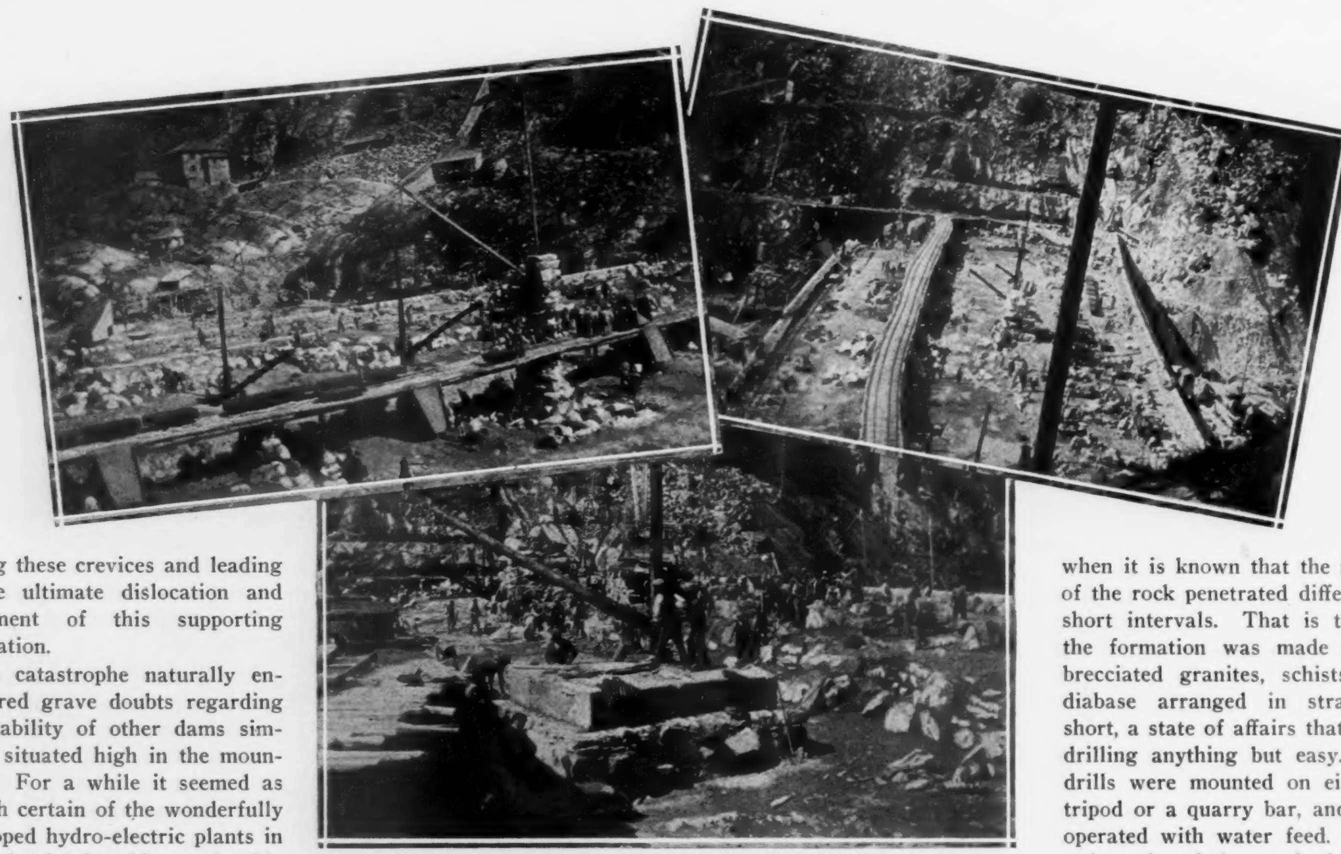
On December 1, 1923, an appalling cataclysm was let loose in northern Italy when the dam forming the artificial lake of Gleno collapsed and freed the impounded waters so that they might rush southward through the Bergamask Valley. The dam was situated at an altitude of 5,078 feet above sea level, and had been completed but a short while before it gave way owing to the tremendous weight of the water accumulated above it. All told, something like 6,540,000 cubic yards of water rushed into the valley below. That fearful torrent poured headlong into the narrow Valley of the Dezzo, gathering velocity and attaining greater violence where its passageway became more restricted. The water carried everything before it, and caused a measure of destruction that the human mind could not have foreseen. Entire villages were swept away; industrial establishments and electric works were destroyed; and more than 450 persons lost their lives. Property damages were estimated at hundreds of millions of Italian lire.



Picturesque aspects of Lake Antrona.

The entire world was horrow struck; and the cause of the catastrophe was a topic of endless speculation. Governmental and judicial investigations tried to establish responsibility, if any lay with anybody; but no errors in design, no defects in the methods employed in erecting the dam—which was of the multiple-arch type—could be discovered. Finally, the theory generally accepted as probably the true explanation was that the dam collapsed because of the yielding or displacement of the bedrock lying beneath the dam. And it was concluded that this displacement was the consequence of crevices existing in the rock when the dam was built—the impounding water penetrating these crevices and leading to the ultimate dislocation and movement of this supporting foundation.

The catastrophe naturally engendered grave doubts regarding the stability of other dams similarly situated high in the mountains. For a while it seemed as though certain of the wonderfully developed hydro-electric plants in Italy—justly the objects of pride on account of the remarkable daring displayed in their creation—would be shut down to safeguard numerous communities against the continuous dread of a disaster kindred to the one that had occurred at Lake Gleno. A careful examination of existing dams and the exercise of rigid control made it plain that these fears were groundless. However, from that time onward extra precautions were taken to make sure that new dams should not fail for the same reason. These precautions consisted in the main of solidifying the rock beds of the dams by injecting fluid cement grout into all possible cracks or cavities in the rock—thus consolidating the supporting rock mass on which a dam was to rise and effectually checking the harmful penetration of water under high pressure. This precaution was found to be of value otherwise, because the grout—forced into the rock under pressure—gave prompt visible evidence of weaknesses or fractures that might not have been brought to light except in this way.



Early stages of work on the dam at Camplicciol.

To make this protective treatment efficacious numerous holes must be drilled in close proximity to one another along the whole line of the dam site, and these holes must penetrate the rock to depths ranging from 26 to 49 feet. At the start, the drilling of these holes presented something of a problem. The question was how to do the work rapidly and at a reasonable cost without obstructing or hindering progress on other essential work nearby. The diamond drill, which was at first tried, proved to be ill adapted to the work because it drilled slowly and was difficult to move from place to place—its derrick occupied much space and made it impossible to drill holes wherever desired.

When the diamond drill was found unequal to the conditions prevailing, the proposal was made to try air-driven rock drills. There were those that did not believe that rock drills of this sort could drill holes to the depths required, especially when called upon to penetrate seamy and broken rock. It was admitted that pneumatic rock drills could drill holes that deep in solid rock and in favorable circumstances. Even so, it was finally decided to make a test with the well-known X-71 drifter. These preliminary trials disclosed how the drifter could be handled to insure satisfactory results. It was therefore chosen for the work—its exceptional drilling and rotating power making it peculiarly fitted for the hard task in hand. Since then, the X-71 drifter has been increasingly employed on work of this nature. Last summer, five outfits of this sort were in operation in the Italian mountains to drill holes on dam sites for grouting. The photographs accompanying this article show the Camplicciol Dam, built by the Edison Company in the Antrona Valley for a new hydro-electric plant.

On the Camplicciol Dam, two X-71 drills were used; but owing to an insufficient supply of compressed air they were rarely operated simultaneously. Before work was suspended, because of the approaching winter, a total of 104 holes had been drilled. Nine of these holes had a depth of 49 feet; 87 of them were 39 feet deep; and 8 of them were drilled to depths ranging from 33 to 36 feet. Approximately 10 of these holes were drilled at an angle of from 25 to 60 degrees. The difficulties encountered can be better understood when it is known that the nature of the rock penetrated differed at short intervals. That is to say, the formation was made up of brecciated granites, schists, and diabase arranged in strata—in short, a state of affairs that made drilling anything but easy. The drills were mounted on either a tripod or a quarry bar, and were operated with water feed.

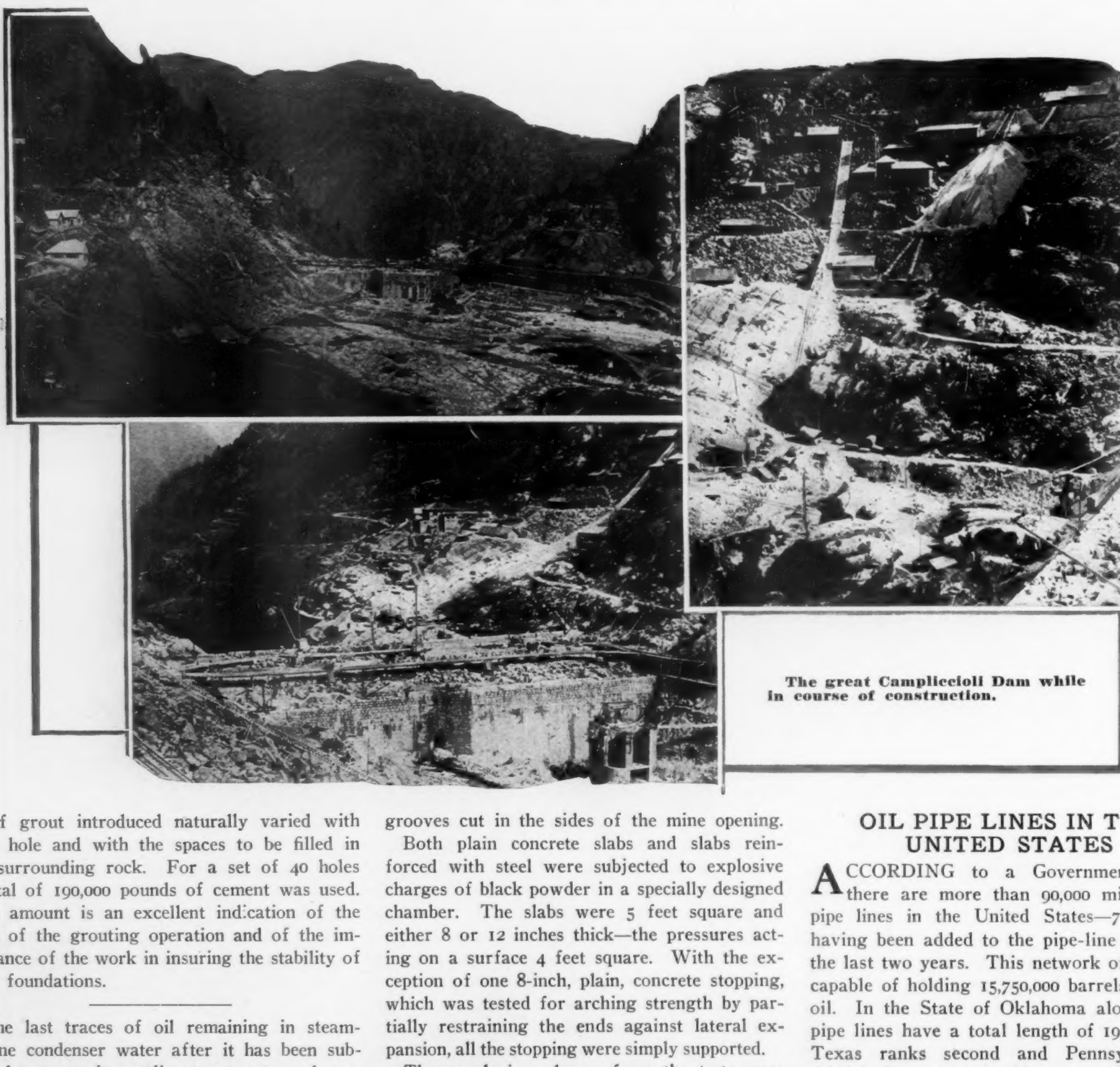
A 39-foot hole required on an average 8 hours of work. The larger part of this time was consumed in withdrawing the drill steels and in cleaning the holes. This cleaning was done with water jets, under considerable pressure, each time a steel was changed. The steels were 1¼ inches in diameter and made from hollow, round "Sandviken" stock, with 4-point bits. As the holes deepened, there was a variation of ⅛ inch in gage in succeeding changes of steels. The steels were in sets up to 40 and 50 feet in length. The diameter at the bottom of the holes was 1⅝ inches in the case of both sets. With the 40-foot set, the starting bit had a diameter of 3½ inches; and the first steel in the 50-foot set had a bit 4 inches in diameter. For those drill steels that were more than 20 feet long the bars were welded in place, and special care was taken not to obstruct or to restrict the hole. In this way excellent results were obtained; and the drills never once broke at the weld. The drills were handled by a very simple derrick, as shown by one of the photo-

Here we see various ways in which "Jackhamers" and X-71 drifters were used in drilling holes at the site of the Camplicciolì Dam.

graphs. The bits were sharpened with a No. 50 "Leyner" sharpener.

After a number of drill holes had been bored, the fluid grout was forced into each one of them under a pressure of 200 pounds. Part of this pressure was obtained by gravity—the grout tank being about 350 feet above the level of the dam; and the remainder was supplied by air at a pressure of 80 pounds. The air pressure was applied to the free surface of the grout in the tank.

The grout was delivered to each drill hole by a 3-inch pipe. At the beginning of the grouting operation the grout was kept very thin and afterwards gradually thickened. The quantity of grout introduced naturally varied with each hole and with the spaces to be filled in the surrounding rock. For a set of 40 holes a total of 190,000 pounds of cement was used. This amount is an excellent indication of the need of the grouting operation and of the importance of the work in insuring the stability of dam foundations.



The great Camplicciolì Dam while in course of construction.

The last traces of oil remaining in steam-engine condenser water after it has been subjected to a gravity settling treatment can be removed by filtering the water through a layer of freshly precipitated aluminum hydroxide. A Dutch engineer is said to be responsible for the suggestion.

Exclusive of Brooklyn, there are more than 6,600 hotels in New York City.

DETERMINING SUITABILITY OF MINE STOPPINGS

RESULTS of tests on plain and reinforced-concrete mine stoppings, employed to prevent explosions penetrating from one portion of a mine to another, indicate that the choice largely depends on prevailing conditions. Where it is possible to obtain solid abutments for taking heavy arch thrusts, plain concrete stoppings, having thicknesses little greater than reinforced stoppings, may be employed. On the other hand, conditions may be such that simply supported or partially restrained slab stoppings are adequate, in which case the steel reinforcement should be carried well into the grooves cut in the sides of the mine opening.

Both plain concrete slabs and slabs reinforced with steel were subjected to explosive charges of black powder in a specially designed chamber. The slabs were 5 feet square and either 8 or 12 inches thick—the pressures acting on a surface 4 feet square. With the exception of one 8-inch, plain, concrete stopping, which was tested for arching strength by partially restraining the ends against lateral expansion, all the stopping were simply supported.

The conclusions drawn from the tests were as follows:

Stresses produced in concrete stoppings by explosive charges of black powder are the same as those produced by static forces of the same magnitude.

Concrete stoppings are capable of carrying higher stresses under explosive pressures which are quickly released or carried to the breaking point than if the pressures are slowly applied.

Plain concrete stoppings will safely and economically withstand explosive pressures where solid abutments are available for taking heavy thrusts and where the construction is such that the shrinkage of the concrete is not appreciable.

Air whistles that will show a powerful light during the period of the blast are being installed in ferryboats for service in San Francisco Bay. The air pressure used to blow the whistle also closes a circuit that operates the light.

OIL PIPE LINES IN THE UNITED STATES

ACCORDING to a Government report, there are more than 90,000 miles of oil pipe lines in the United States—7,000 miles having been added to the pipe-line system in the last two years. This network of piping is capable of holding 15,750,000 barrels of crude oil. In the State of Oklahoma alone the oil pipe lines have a total length of 19,180 miles. Texas ranks second and Pennsylvania is third in importance in this means of distributing petroleum from the wells to the distant refineries.

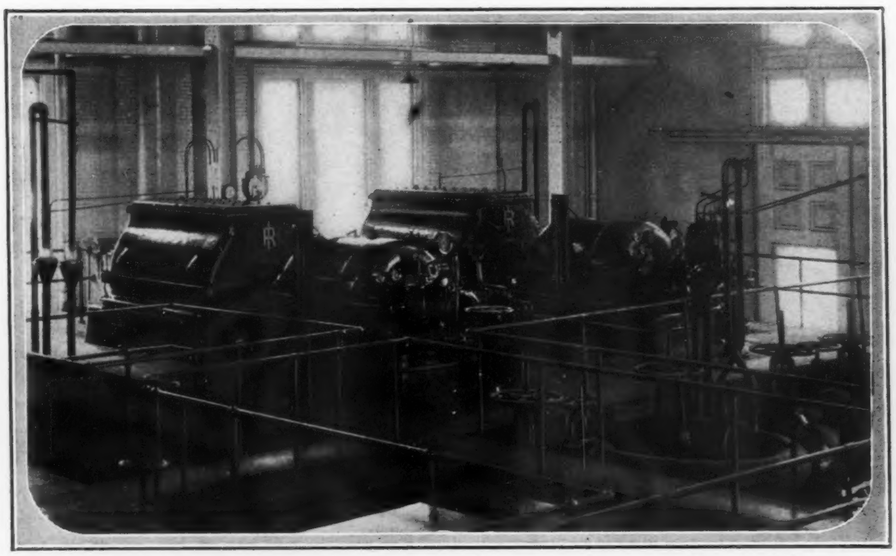
Pipe lines range in diameter from 2 to 16 inches—the average prevailing diameter being 6 inches. The pipe-line mileage is about equally divided between the trunk lines and the tributary or gathering lines.

Where The Navy Builds Its Big Guns

Amazing Precision Insisted Upon in Fabricating Rifles That Develop Tremendous Energy

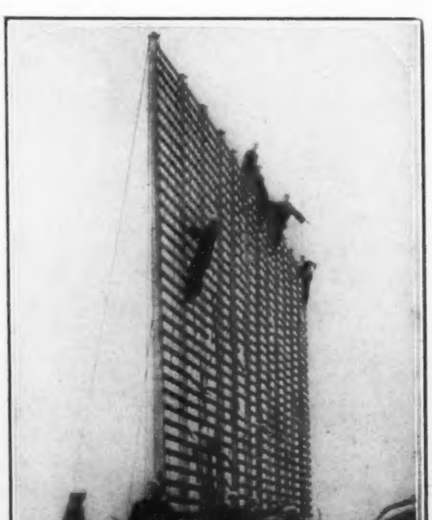
By G. H. DACY

COMPRESSED air contributes in many and various ways at the United States Naval Gun Factory, Washington, D. C., to the production of all kinds of naval armament and allied accessories. The business of maintaining the Navy's ordnance "in fit condition for mortal strife" is a stupendous one at this plant, which bears the distinction of being the greatest of its kind in the nation and one of the finest in the world. Our Navy now aggregates 18 battleships, 8 armored cruisers, 11 scout cruisers, more than 300 destroyers, and 80-odd submarines. The ordnance of this mighty fleet ranges from 3-inch guns to the 16-inch giants that fire 2,100-pound projectiles.



Turbo-compressors, each with a capacity of 5,000 cubic feet a minute, furnish some of the operating air used in the United States Naval Gun Factory.

Compressed air is the operating force for machines that shape and mold by-products and obsolete equipment into the finest ordnance steel that it is possible to produce. It exerts its power and energy through hammers, chippers, planers, drills, blow torches, oil burners, molding machines, vibrators, sand sieves, shot blasters and other mechanisms. In supplanting the manual methods once employed, compressed air has served greatly to increase efficiency and to reduce costs of ordnance production.



Rigging up a target for practice firing by the battle fleet.

The general compressor plant has a capacity of 12,100 cubic feet per minute. It includes two I-R turbo-driven rotary units, each capable of delivering 5,000 cubic feet of air per minute. Four steam-driven compressors, formerly the principal source of supply, remain in place for emergency service. In the gun-carriage shop there is a small motor-driven compressor. Its presence saves operating the general compressor plant at night. In this shop air is used to drive drills, chipping machines, and pneumatic hammers, and to reverse planers. It also is employed on a 25-foot vertical boring mill to release or to clamp the rail on the housing. Before air was available this work had to be done slowly and laboriously by hand.

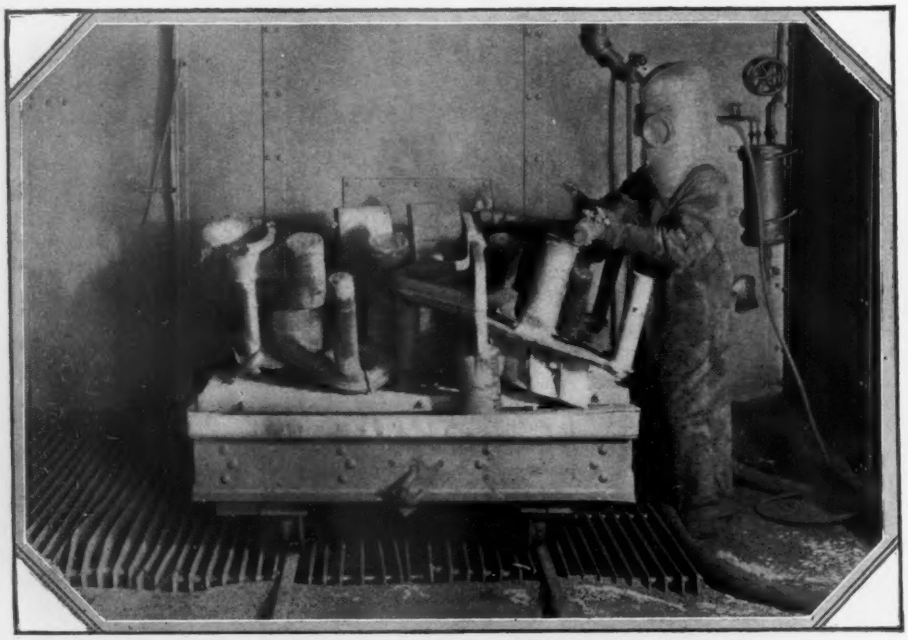
In the power plant, which comprises a battery of 22 boilers having a combined capacity of 12,000 H.P., a special pneumatic tube cleaner is used once every three months to clean all boiler tubes and drums. The repair and maintenance activities of the power plant require compressed air for drilling and chipping and for keeping the generators and switchboard dust free.

The foundry in the Navy Yard can produce as much as 100,000 pounds of the finest quality ordnance steel in a day. It is equipped with a 30-ton open-hearth furnace, a 6-ton electric furnace, and two large converters. From scrap, such as discarded gun mounts, a superior steel is made. In 1925, approximately 150,000 castings of steel, brass, and iron were turned out in that department of the yard. Some of these weighed as much as 45 tons, and their combined weight was in excess of 1,000 tons.

Compressed air operates as many as 269 tools and machines of 12 different classifications in this naval foundry. Air-operated molding machines accommodate flasks ranging in size from 13x18 inches to 6 feet square. These machines vary from the jar-ram type and the combination jar-and-squeeze type, to the jar-squeeze, pattern-stripping type. Compressed air is used in each case to perform the ramming, to turn over the flasks, and to draw the patterns. The air-driven rammers that now ram the sand into the molds do as much work in a given time as 6 men with hand rammers.

Seventy-five vibrators, which have supplanted hand rapping, have measurably increased production and insured more satisfactory castings. Low-pressure and high-pressure-air oil burners are employed where heat is required for ladels, molds, or ovens. The "blow-off" hose has replaced the old-fashioned bellows, while siphons remove dust and dirt from sand molds after they have been made; and a mixture of molasses water, silica wash, and blacking is applied to the molds by an air spray.

The telescopic sight, with which each naval gun is fitted, is manufactured and assembled with the utmost care.



Sand blasting castings for gun mounts.

Numerous sand sieves, having a capacity of 200 tons of sand daily, are operated by air and have proved themselves to be tenfold more effective than the older hand-sifting methods.

All newly made castings, before further work is done on them, are cleaned and freed of any sand that may cling to them by steel shot applied with air under 100 pounds pressure. This is done in a special chamber by an operator garbed after the fashion of a deep-sea diver in order to protect him against the fine sand, scales, etc., removed from the castings by the flying pellets of steel. Meters at various points along the air-distributing system leading from the general compressor plant to the steel and brass mills show that more than 75,000,000 cubic feet of compressed air is needed annually in these foundry operations.

In the 5-story machine shop there is an auxiliary compressor plant that furnishes air for testing submarine torpedoes. It consists of two compressors, each of 4,000 cubic-feet-per-minute capacity. The trials are carried out in large steel tanks, filled with water; and air under a pressure of 250 pounds is used to expel the torpedoes from the tubes. Thus the individual characteristics and peculiarities of each torpedo are determined and recorded. With these data at hand, those who are eventually called upon to fire the torpedoes know beforehand how each one will act and can therefore handle it accordingly.

The compressed air for the torpedo tests is stored in steel cylinders 5 feet high and 6 inches in diameter. Twenty-five of such containers, grouped in what is termed a "nest," are filled with air under a pressure of 3,000 pounds per square inch. Each cylinder contains sufficient air to fire one torpedo under test conditions.

The air supply is contained in the body or flask of the torpedo and serves as the motive force for the engine which propels the torpedo in its sub-surface run. When a torpedo is fired experimentally, the pressure is lowered just as the projectile leaves the tube in order that no damage be done either the torpedo or the tank. Despite this reduction in pressure, it is possible for scientific observers, by the aid of special recorders, to secure all the desired data.

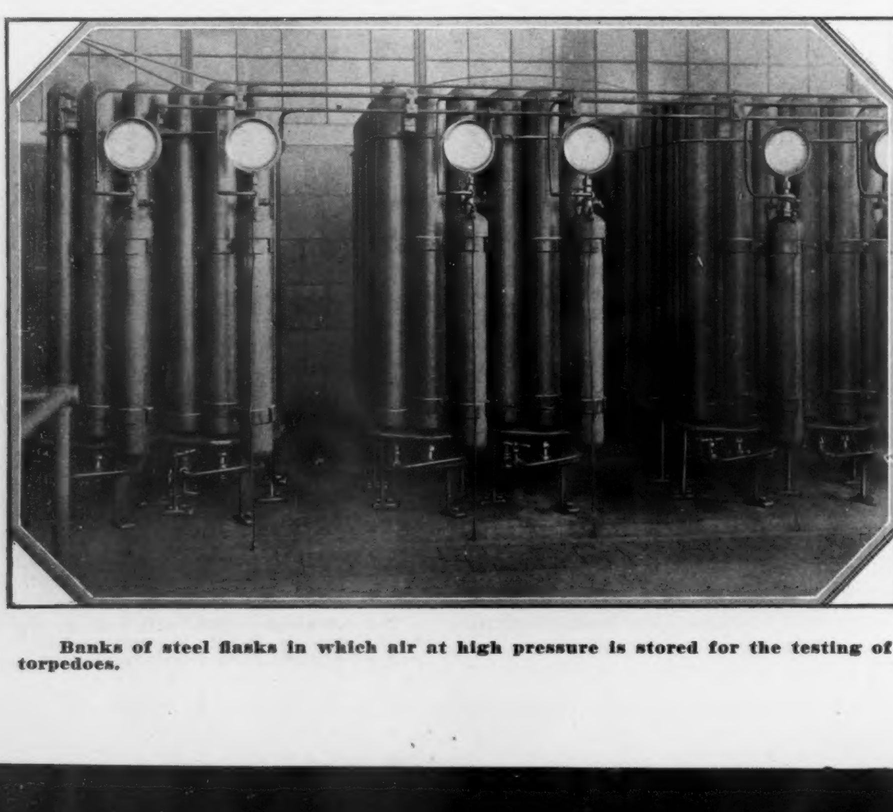
Another purpose of this particular compressed-air plant is to provide air for the hydro-pneumatic recoil system that is a part of the naval guns manufactured and repaired at the Naval Gun Factory. And it is air from this source that successfully operates the gas ejectors, originated at the Washington Navy Yard, and now used on all turret guns ranging from 6 inches to 16 inches in size.

The modern recoil system replaces springs that worked by compression. Those springs were designed to develop a certain initial load and, thereafter, a maximum load which, by compression, would throw the gun back to normal battery position after it was fired. In the case of the hydro-pneumatic recoil system, the compressed air is stored in recuperative cylinders—the air supply being pumped up to an initial pressure and held there until the gun is discharged. When the gun recoils, after firing, this action compresses the air to a still higher pressure and forces the rifle back to its normal battery position without any appreciable jolt, jar, or jam.

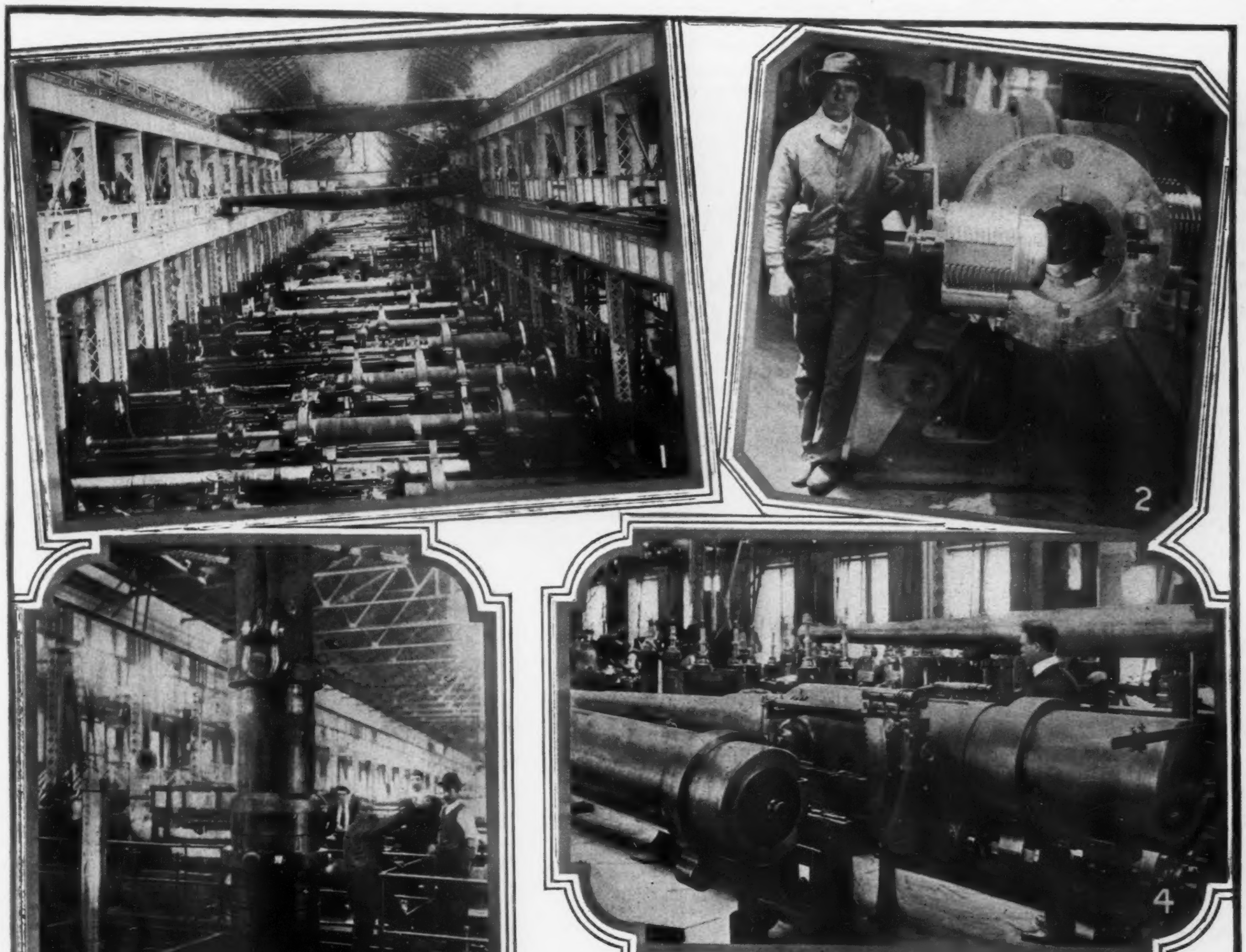
The compressed-air gas ejector serves to expel from the gun all the flames and burning gases, unburned powder, and other materials that might otherwise cause a flareback when the breech is again opened. Each gun is now provided with an air-storage tank with a special bank and leads that connect with the gun. A valve, which is automatically operated by the movement of the breech plug, permits a rush of air through the gun directly after firing to blow out the burning gases, etc. With the exception of those using fixed ammunition—cartridge-case-mounted ammunition—all naval guns are now equipped with these necessary gas ejectors.

In the erecting shop of the gun factory, compressed air is employed to run drills, hammers, and grinding and lapping machines; and all rivets used are heated in air forges. Between 3,500,000 and 4,000,000 pounds of forgings are produced annually in the yard's forge shop. There, the raw materials are delivered in the form of ingots, some of which weigh many tons. Each ingot is first heated to the customary forging temperature of 2,200° F., and then a traveling crane transports the incandescent mass to a steam hammer or hydraulic press where it is forged into the desired form and dimensions. The equipment in this shop includes one of the largest hydraulic steam presses ever made. It can strike a blow of 4,000,000 foot-pounds; and its weight of 2,000 tons necessitated the use of 30 freight cars for its transportation to the Washington Navy Yard.

Compressed air also is used in this department of the plant to vaporize the oil burned in the forging furnaces that provide the intense heat needed. Streams of air distribute the fuel so as to produce the most effective flame.



Banks of steel flasks in which air at high pressure is stored for the testing of torpedoes.



1—Some of the Navy's powerful rifles undergoing machining in the main gun shop at the Washington Navy Yard.
2—Each breech mechanism must fit a standard test breech before it is accepted for service.
3—Lowering a heated jacket on to the upright inner tube of a 12-inch rifle.
4—Lining up the sights on an 8-inch gun.
5—Close-up of some of the great lathes machining the jackets of big guns.
6—Furnace in which the steel jackets are heated that are afterwards shrunk upon the inner tubes of naval rifles.

The same thing applies to the oil-burning forges and ovens. Likewise, compressed air blows the iron-oxide scale from the red-hot forgings after they have been shaped and sized. The quenching medium in which the forgings eventually are cooled and hardened is agitated by air. The large volume of low-pressure air required for these various services is furnished by four compressors in the forge shop.

In the cartridge-case factory, quantity production has been expedited by substituting a modern pneumatic chuck for the older hand-operated type. In fact, its use has increased the output of this department 50 per cent. The air chuck is employed in machining rotating bands and in trimming cartridge cases. It can either trim 350 cartridge cases or turn 450 rotating bands in a day. Additional machines of this type, which need but one attendant, are to be installed.

A 30-foot plate planer, equipped with 16 individually operated and controlled compressed-air jacks, is an interesting piece of machinery in the boiler and structural shop. Steel plates up to 2 inches in thickness are planed by this machine—pneumatic clamps holding them firmly the while. This part of the work was formerly done by ponderous screw clamps and hand jacks. A bull riveter that puts holes up to 1⅛ inches in diameter in solid steel, and a riveting machine that handles rivets of similar size are actuated by compressed air.

The gun shop is housed in a building 572 feet long, 243 feet wide, and 135 feet high, and is equipped with the finest tools available for ordnance production. Guns are made and repaired there ranging from 1-pounders to those having bores 16 inches in diameter and lengths of 50 calibers. The hundreds of small and large guns of our naval fleet are returned to Washington whenever they require new liners, re-rifling, or other repairs or adjustments. The 16-inch guns weigh 286,135 pounds each, yet the yard's electric cranes, lathes, and shrinkage pits are able to handle them with ease.

In this shop, compressed air operates the blow torches employed to remove screw-box liners from guns undergoing repairs or adjustment. These screw boxes are in some instances as much as 48 inches in diameter. The standard length of this liner is 14 inches, of which all but 4 inches—which project beyond the breech—are inside the gun. The air torches, with a nozzle diameter of ¼-inch, throw flames having a maximum radius of 9 inches. In order to remove the liner from a 12-, 14-, or 16-inch gun, the exterior surface has to be heated to a temperature of from 400° to 500° F. As the liner was originally shrunk into place, it is necessary to expand the breech section of the gun slightly in order to remove the liner. Subsequently, a new screw-box liner can be shrunk into position by heat treatment, or the old one can be replaced after it has been repaired.

The heat treatment of big guns is so spectacular that it merits a brief description. Because of the unstable nature of the ground on which it stands, the steel-and-concrete shrinkage pit was built from the top down instead of from the bottom up. The concrete walls are 6 feet thick, while the floor is 10 feet thick. The pit is divided into 10 gun wells, each of which is provided with an elevator large enough to handle any size of gun.

Four huge electric furnaces are included in the equipment, and each can accommodate one gun. It is in these furnaces that the guns are heated in which liners are to be renewed—the guns remaining in the furnaces for about 20 hours. During this period they are subjected to heat at a uniform temperature produced by numerous electric coils. As a result of this treatment the metal expands, making it possible to remove the old liner and to put a new one in its place. The steel jacket, as it subsequently cools and shrinks, grips the liner more firmly than could any bolts, nuts, or screws, regardless of their size and strength.

Thus compressed air, steam, and electricity, with machinery of an unusual type and skill of a high degree, all combine to turn what might be considered waste material in many factories into the best ordnance that can be manufactured. In the United States Naval Gun Factory only the highest order of production practices are tolerated; and in the gun factory, just as in any up-to-date commercial plant, is employed every available means and method that will make for operating economy while turning out guns of unsurpassed excellence.

WOOD THAT CAN BE MOLDED

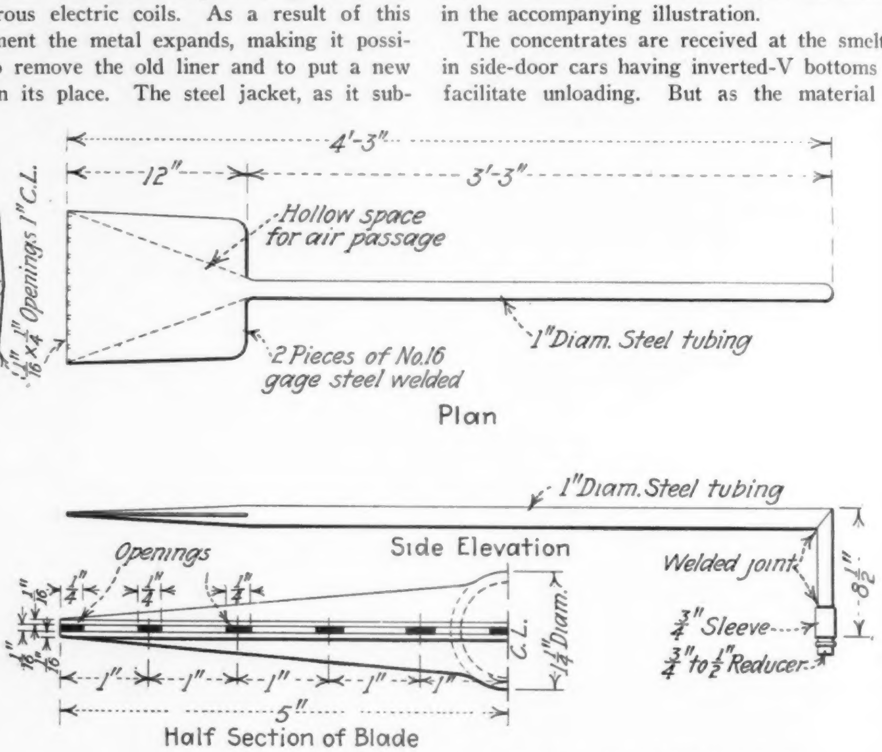
It is now possible to buy wood in cans—not wood as we ordinarily know it, but wood in a soft plastic state intended to fill undesirable holes and cracks. This material is known as "Plastic Wood."

According to *Machinery*, the substance hardens soon after use; can be carved, planed, sandpapered, or turned in a lathe; and will take paints, stains, and varnishes the same as wood. When hard, screws and nails can be driven into it without splitting it—in fact, it is said that "Plastic Wood" differs from natural wood only in that it has no grain.

AIR SHOVEL HELPS UNLOAD MOIST BULK MATERIAL

A CONSIDERABLE reduction in the time required to unload concentrates at the Clifton, Ariz., smelter of the Phelps Dodge Corporation has resulted through the use of a compressed-air shovel devised by T. A. O'Neil, foreman of the smelter's preparation department. The details of this shovel are shown in the accompanying illustration.

The concentrates are received at the smelter in side-door cars having inverted-V bottoms to facilitate unloading. But as the material is wet and heavy—containing from 9 to 11 per cent. of moisture—it clings to the car bottom and shows little disposition to move down the inclined slopes. Formerly, the three or four men, with regulation shovels, assigned to empty the cars were assisted by compressed air introduced through a ½-inch pipe jabbed here and there into the top of the mass. The average time required to unload a car in this way was from 20 to 30 minutes.



Courtesy, Engineering & Mining Journal.

General arrangement and details of the unloading shovel equipped with a compressed-air discharge for loosening compacted materials.

The shovel now utilized is a combination air pipe and shovel, thus making both the force exerted by the workman and the pressure of the air available at the point of application. In trying out the new shovel, using air at a pressure of 75 pounds, it was possible for one man in 7 minutes to unload and to clean a car containing 45 tons of wet concentrates.

But under actual working conditions two men are now engaged in the unloading of the concentrates that reach the plant in trains of from 6 to 10 cars each. Exclusive of spotting, and to assure a thorough cleaning of each car to prevent wastage, these two men with their compressed-air shovels take on an average 10 minutes to empty a car. Aside from cutting the working time in half, the new compressed-air shovel has measurably reduced the cost of unloading, which now comes to only one-third cent per ton of concentrates.

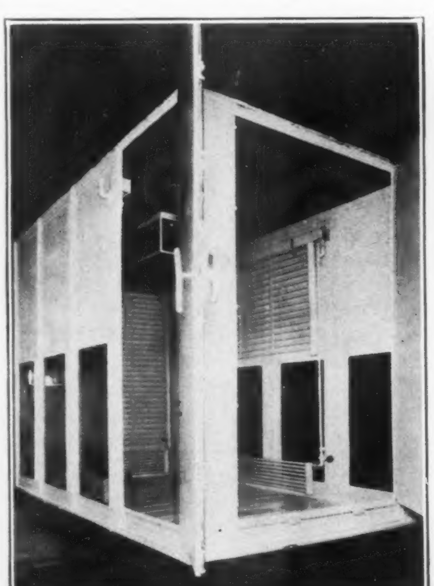
Oxygen Aids in Battle With Pneumonia

ONE of the most recent developments in medical science is the oxygen chamber, used to save critical pneumonia cases. It was designed by Dr. Alvan L. Barach of the Presbyterian Hospital, New York City, and is an example of the type of work being done at that hospital, which is coöperating with Columbia University to form one of the largest medical centers in the world.

The use of oxygen as a restorer is nothing new. As long as 200 years ago it was advocated by chemists and doctors. But, as applied then, it was not found very serviceable. Little was known of the amount that should be given a patient under definite circumstances; and so unsuccessful was the work done with oxygen that doctors came to look askance upon its use.

During the last few years, however, intelligent experiments and cautious usage have tended to give a more definite idea of just what oxygen means as a therapeutic agent; and clinical cases, which have come under the observation of the men who are developing the medical use of oxygen, have revealed the fact that oxygen may prevent death in many pneumonia cases.

The oxygen tent is one of the first satisfactory appliances employed in administering the element to patients. Other means, such as a mask, caused some discomfort. An accompanying picture shows how the tent is utilized. As the fabric of which it is made is relatively tight, and as the enriched air within is constantly recirculated, there is little waste of the oxygen used. The necessary supply of oxygen is carried in a large cylinder under high pressure and is thence fed slowly into the tent—a regulator at the top of the cylinder controlling the pressure and a gage indicating the flow of oxygen in liters per minute. In the cylinder at the right of the movable apparatus is ice, which serves to cool the oxygen so that the temperature in the tent may be comfortable for the patient. A third cylinder contains soda lime, and this absorbs the carbon dioxide from the air. The oxygen passes over the ice into the tent, whence it goes outward by way of the soda-lime tank. Then the air is fed once more over the ice and back into the tent—suitable apparatus being interposed in order to determine the percentage of oxygen in the tent. The tent can be made ready for service within fifteen minutes after a call has been made for it.



An aluminum chamber which can be sealed and filled with oxygen for the treatment of patients suffering with pneumonia.

The oxygen chamber operates on a different principle—its main advantage over the tent being that it provides greater comfort for the patient. This chamber, constructed of aluminum and made so as to be air-tight, is an outstanding achievement in the work done by Doctor Barach in this field. There are only five such rooms in existence: two in England, one of which is at the Guy Hospital; and one each at the Mayo Hospital, in Rochester, Minn., and at the Rockefeller and the Presbyterian hospitals, New York City. Complete, a chamber of this description can be constructed for as little as $2,500. The chamber pictured, which is at the Presbyterian Hospital, is different from the others in that it does not require motors and fans for ventilation. Cold circulating water passes through the chamber by way of aluminum piping—the water entering the pipe at one side of the chamber and being discharged into a drain at the opposite side. A large soda-lime container is placed under the bed. No other apparatus is required.

Clinical experiments have proved that between 40 and 60 per cent. of oxygen is the right amount for a patient. This rich mixture acts well as a therapeutic agent; but it is believed that in most cases an increase in the percentage of oxygen in the air beyond 60 per cent. will not act favorably. Because doctors have been inclined to look with little confidence upon this type of therapeutic agent, the tent and the chamber have not been used to any great extent, and then only as a last resort when every other means to save a patient's life had failed. Nevertheless, out of ten test cases, treated in the oxygen tent at the Presbyterian Hospital, seven recovered, while four out of six critical cases in the portable chamber recovered. All but one of the patients treated in the tent were gravely ill. The invalids were subjected to the treatment for from two to seven days.

That oxygen, as such, cures a patient is not considered at all likely; but medical men are more and more inclined towards the opinion that oxygen is a powerful weapon against pneumonia by assisting in the prolonging of life until a patient has passed the crisis and is able to accomplish a natural recovery.

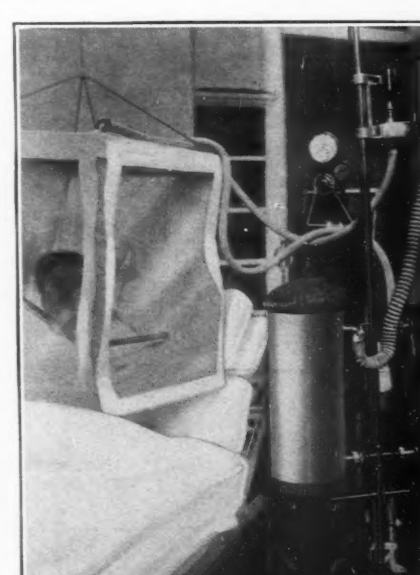
SAVING FUEL BY MORE EFFICIENT USE

BY burning fuel more efficiently in 1926 than in preceding years, the public-utility electric plants of the United States have been able to maintain rates prevailing since the World War despite the constantly increasing cost of fuel. This has been done primarily by building larger generating plants along modern lines, by improving plant interconnections, and by increasing and bettering the loads.

The United States Geological Survey states that there was a 52 per cent. increase in efficiency in the utilization of fuels during the period from 1919 to 1925 inclusive. For 1926, the average consumption of coal per kilowatt-hour of electricity produced was only 1 pound in plants of thoroughly modern design. In 1925, the figure was 2.1 pounds for all steam plants in the country.

In addition to facing 80 per cent. greater operating costs, the industry was confronted in the post-war years by public opinion hostile to any rise in rates. "On this account," says the Geological Survey report, "no relief could be obtained through appeal to the public-utility commissions. The power companies were therefore forced to seek methods of reducing costs of operation, and they soon found a broad field for such reduction in the better utilization of fuels."

Coal continues to be the principal fuel used in producing electricity—gas and oil being consumed only in those regions where their abundance makes them relatively cheap. The report points out that, owing to the great amount of electric power generated, a saving of but one-fourth pound of coal for each kilowatt-hour produced in 1926 would have conserved about 6,000,000 tons, valued at approximately $25,000,000.



Improvised tent with connections for delivering air containing a high percentage of oxygen to a pneumonia case.

Story of the Growth and Expansion of Carbide Production

By E. H. SHARP

ONE outstanding similarity of many great American business enterprises is that, in a short period of time, they have grown from small beginnings to organizations of vast proportions. The manufacture of calcium carbide, with its partner products, is one of the most pronounced examples of this phenomenon. Moderately successful laboratory experiments were carried on with carbide as early as 1836. But it was not until 1892 that the work started which was to give to the substance the tremendous commercial value and importance that it now enjoys. At that time, Maj. J. T. Morehead and Mr. Thomas L. Willson set to work near a little cotton mill at Spray, N. C., to utilize excess water power which was not required for the mill. The electric furnace—then little more than a scientific toy—appeared to be a feasible means for converting water power into high temperatures for smelting purposes. The men, accordingly, built one of the first electric furnaces put into commercial operation in the United States.

Oxwelding a gray-iron casting.

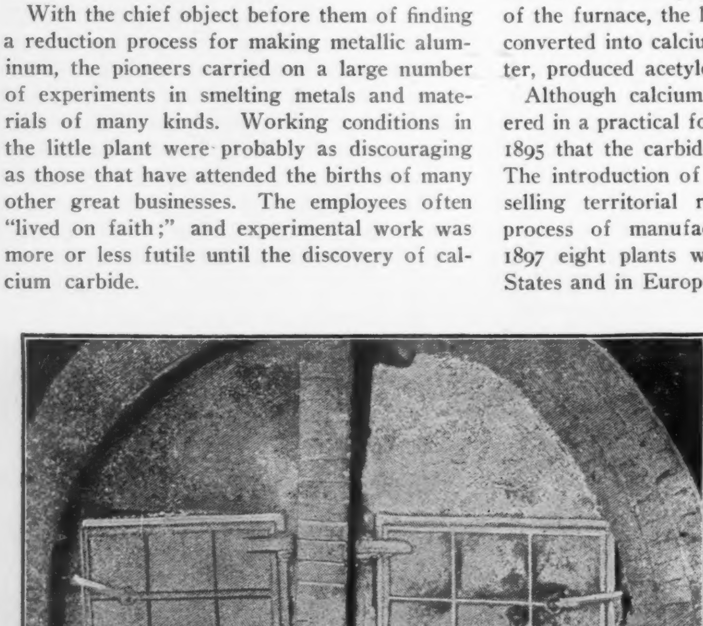
With the chief object before them of finding a reduction process for making metallic aluminum, the pioneers carried on a large number of experiments in smelting metals and materials of many kinds. Working conditions in the little plant were probably as discouraging as those that have attended the births of many other great businesses. The employees often "lived on faith;" and experimental work was more or less futile until the discovery of calcium carbide.

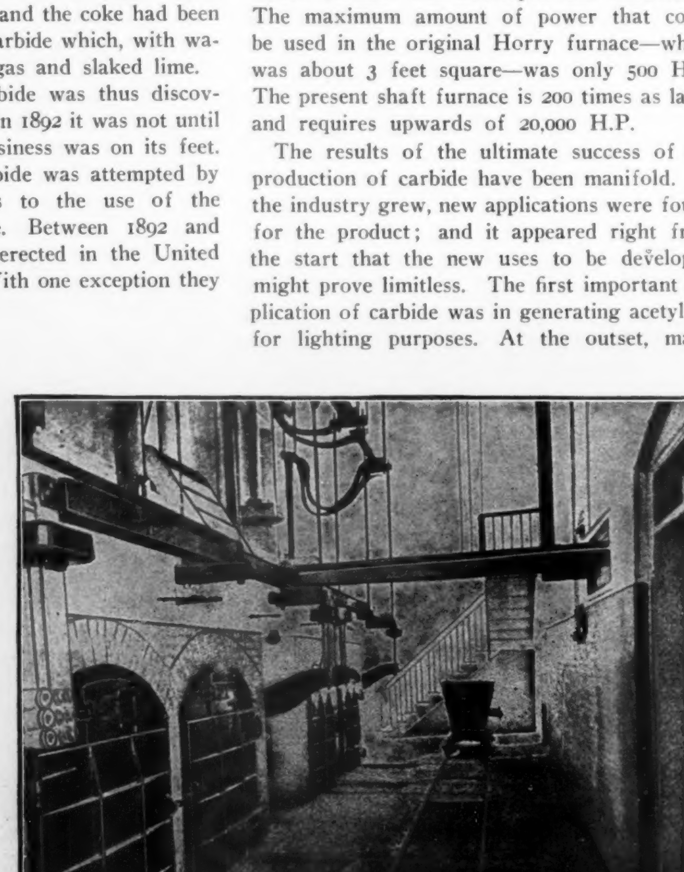
Like so many other discoveries, it was totally unexpected. To a mixture of coke and ore, which was in the furnace, lime was added to obtain a flux. The run gave no reduced metal. The residue was taken from the furnace, and water was thrown on it to cool it. Then, to the surprise of those present, a cloud of pungent gas was given off. This was later found to be acetylene. Under the great heat of the furnace, the lime and the coke had been converted into calcium carbide which, with water, produced acetylene gas and slaked lime.

Although calcium carbide was thus discovered in a practical form in 1892 it was not until 1895 that the carbide business was on its feet. The introduction of carbide was attempted by selling territorial rights to the use of the process of manufacture. Between 1892 and 1897 eight plants were erected in the United States and in Europe. With one exception they were commercial failures. In the words of Mr. Joseph Scales, one of the men who took part in the early work and who is still actively engaged in the business, "It looked as if carbide would prove to be a picturesque and interesting feat of laboratory science, but a negligible quantity so far as practical utility was concerned."

The one plant which found that practical difficulties were not insurmountable was located at Sault Ste. Marie, Mich. The success of this particular venture was largely the result of another invention, the Horry furnace. Because it made continuous and economical manufacture possible, this furnace saved the business of carbide production from an immediate, if only temporary, demise. It satisfied the promoters that the production of calcium carbide was a sound and promising enterprise. The period which followed was one of fast and sensational growth. The amount of power utilized was greatly increased. Later, a new type of enclosed furnace was developed and introduced. The maximum amount of power that could be used in the original Horry furnace—which was about 3 feet square—was only 500 H.P. The present shaft furnace is 200 times as large and requires upwards of 20,000 H.P.

The results of the ultimate success of the production of carbide have been manifold. As the industry grew, new applications were found for the product; and it appeared right from the start that the new uses to be developed might prove limitless. The first important application of carbide was in generating acetylene for lighting purposes. At the outset, many





Left—The electric furnace used in 1892 in the experimental plant at Spray, N. C.

Right—Carbide furnaces employed in the industry back in 1898.

difficulties were encountered in the attempt to devise a satisfactory generator in which the acetylene could be produced. Many individuals experimented with all kinds and descriptions of generators. Not all of these were safe contrivances by any means; and, consequently, there was danger that acetylene might be looked upon as a public nuisance. It was finally decided, in 1905, that the carbide company should coöperate in the experimental work; and in this way the company ultimately established an apparatus- and generator-manufacturing business of its own. Thus another problem was solved.

The immediate concern, of course, was to create a market for carbide. About 1904 another important development took place. Heretofore, acetylene gas had always been generated at the point of use. Now methods were perfected whereby the gas could be generated at a central plant and shipped in cylinders ready for immediate service—the gas being dissolved in a liquid solvent and the solvent, in turn, being absorbed by a porous filler within the cylinder. This was one step forward. Although the sales immediately spurted—as this development made acetylene practicable for automobile lighting and other portable purposes, it was impossible to foresee just how important a step it was destined to prove. As a matter of fact, "dissolved" acetylene, or Prest-O-Lite, has been put to dozens of uses, not the least of which is oxy-acetylene welding and cutting.

Heretofore carbide lighting had been the most important phase of the industry. The new illuminant had been used in lighting the homes of the rich and the poor, railways, waterways, mines, streets, buildings, and automobile headlights. It was extended to stereopticons, picture machines, and the heliographic work of the army and the navy. With flashing buoys, highway signals, and air-way markers, acetylene is now helping to light the nation's traffic. But the utilization of carbide for the generation of acetylene for welding and cutting purposes was destined to become equally important. It is reliably estimated that industry, by reclaiming machinery by welding rather than by replacing it, now saves nearly $500,000,000 annually. And oxy-acetylene welding and cutting are by no means confined to reclaiming broken machinery.

Oxwelding was made commercially practicable by a process which achieved industrial importance about 1907, when oxygen was manufactured by separating the atmosphere into its component gases. This process consists of cooling and compressing air—a mixture of nitrogen and oxygen gases—by stages until it liquefies at a very low temperature. Warming this liquid air slightly causes the nitrogen to vaporize and to leave liquid oxygen behind. It is thus worthy of comment that acetylene and oxygen—the first a product of the intense heat of the electric furnace, and the second a product of intense cold—themselves unite to make the hottest flame known to science. It is this flame that is used in modern welding processes.

Oxwelding is now employed in many industries in the United States. It has long served the building contractor to advantage, and it may do so even more in the future. For instance, it has enabled the steam fitter to install pipes where otherwise it would have been impossible to run them without incurring unnecessarily heavy expenses. Wrought-iron, steel, copper, and brass-pipe specials are welded right on the job with important savings in initial cost and gains in ultimate satisfaction. It is a simple matter for an operator to fabricate return bends, reducers, end plugs, and tees to suit any need. One of the greatest assets of the welded pipe in building construction affects the architect, because his task of designing is consequently much simplified. As for the contractor, instead of having certain specified lengths of pipe sent to the scene of operations, he can order his steel pipe in stock lengths and cut it on the ground, to suit special requirements, with an oxy-acetylene cutting blowpipe.

With the elimination of fittings, many of the steam fitter's most serious troubles must vanish. Cost is lowered, as compared with installations where fittings are used. There is no need of accurate trimming, such as is necessary when the pipe is threaded. Furthermore, welded joints are permanently tight: between pipe lengths and between pipe and fitting they will be leakless from first to last. Along this same line, oxwelding has facilitated the installation of gas, oil, and water pipe lines. Although many examples are available of how long welded pipe lines have given satisfaction, one incident will suffice to illustrate this point.

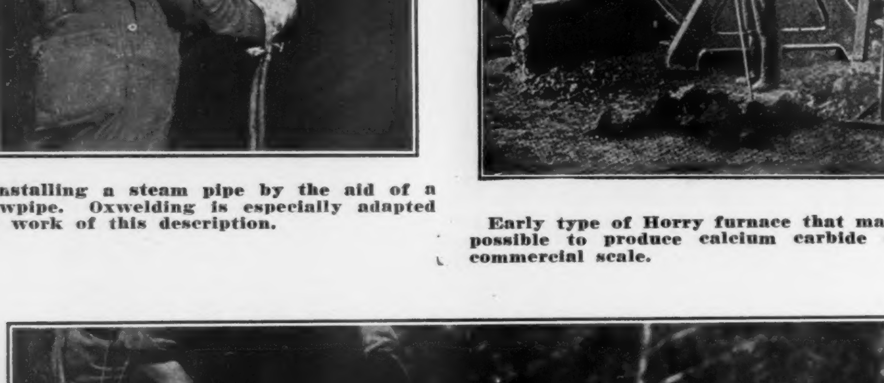
Upper level of a modern carbide furnace. The raw materials enter the furnace by way of this floor.

Running out carbide on the lower lever of a furnace.

Packing carbide in drums for shipment.

Installing a steam pipe by the aid of a blowpipe. Oxwelding is especially adapted for work of this description.

Early type of Horry furnace that made it possible to produce calcium carbide on a commercial scale.



Welding sections of an oil pipe line.

A gas line had been laid through the coastal range of a western state. A section of it, where it descended to a lower altitude, was buried beneath the bed of a smoothly flowing river. A spring freshet washed out part of the bed of the stream, exposing the pipe line for a distance of 150 feet. Still under pressure, the pipe remained suspended above the stream for two days. Another heavy downrush of water cut into the bank of the stream and washed away an additional 50 feet of supporting earth. Unfortunately, the line now began to sag until it lay just on the water. The force of the torrent was so great that it would carry the line downstream about 2 feet. The line would then whip out of the water and return to its normal position, where it would again be caught in the current and swept downstream. This action occurred regularly; and the constant whipping continued several hours.

This was the situation when a section of railroad track and the wreckage of a derrick were seen coming down with the current. As a precaution, the valves in the line were promptly closed. But when the wreckage struck the pipe, the welded joints held. For 45 minutes the debris pushed against the pipe without breaking it. At last the strain proved too much, and the line snapped. So great was the pressure when the rupture occurred that it parted the water, exposing the bed of the stream momentarily. With this convincing proof of the strength of oxwelded joints, the engineers immediately installed a new but temporary welded line. Later, a second permanent line with all welded joints was laid in place of the first one, which did so much more than could be expected of it.

In laying pipe lines in city streets, oxwelding plays an important rôle. Such lines must be able to resist corrosive elements in the earth, withstand peculiar vibrational stresses, and remain permanently tight. Besides, the city lines must follow contours that are often eccentric, extreme. Generally, these contingencies are unexpected—that is, they are not discovered until the underground path is opened up. No planning beforehand can possibly take care of all the conditions that may arise; and the required lengths of straight pipe, bends, ells, tees, and other specials of this kind, must frequently be provided rapidly and, if possible, on the spot, if serious delay is to be avoided. These contingencies can all be met by the oxy-acetylene-welding process.

Outside of the field of repair and equipment maintenance, oxwelding is extensively applied in the fabrication of a great variety of things. Welding facilitates the manufacture of all sorts of plant equipment and jigs, metal furniture, hospital equipment, ornamental ironwork, artificial-refrigeration coils, dies, cooking utensils, condensers, airplane fuselages, etc., etc. One could go on almost indefinitely listing the products into the manufacture of which oxy-acetylene welding enters.

Besides its thousand-and-one welding applications, the oxy-acetylene flame is widely used in cutting metals. In this connection, it facilitates the razing of buildings, the scrapping of antiquated plant equipment, battleships,

boilers, and tanks, and makes it easy to get rid of so-called skulls, ladle spills, and salamanders around blast furnaces and steel plants. The oxy-acetylene flame also speeds up the cutting of pipe lines for branches, and the making of signs and wrought-iron ornaments.

In still another way the oxy-acetylene blowpipe is being put to service. In heating metal, for bending, this type of blowpipe is being adopted by many producers, and for this work is supplanting forges to an ever-increasing extent. A few examples of this application are: heating and shaping steel strips for making shoe dies and pipes for refrigeration coils, straightening smashed automobile frames, cleaning tire molds, melting Babbitt, hardening spots in steel or malleable iron, and softening hard spots on castings.

Carbide, with its partner products, therefore operates in a large field—in fact, it is wellnigh indispensable in one way or another to manufacturing and metal-using industries. And in repairing equipment and in speeding up production, carbide makes millions of dollars annually for American business.

RAILROAD SHOPS FIND NEW WAYS TO USE AIR

COMPRESSED AIR is extensively used for many purposes in railroad shops; and, owing to its ease of handling and control, is being drawn upon to do all sorts of unusual services and to do them far quicker, if not better, than they could be accomplished by the methods abandoned. The following two examples of recent applications of compressed air will make this plain.

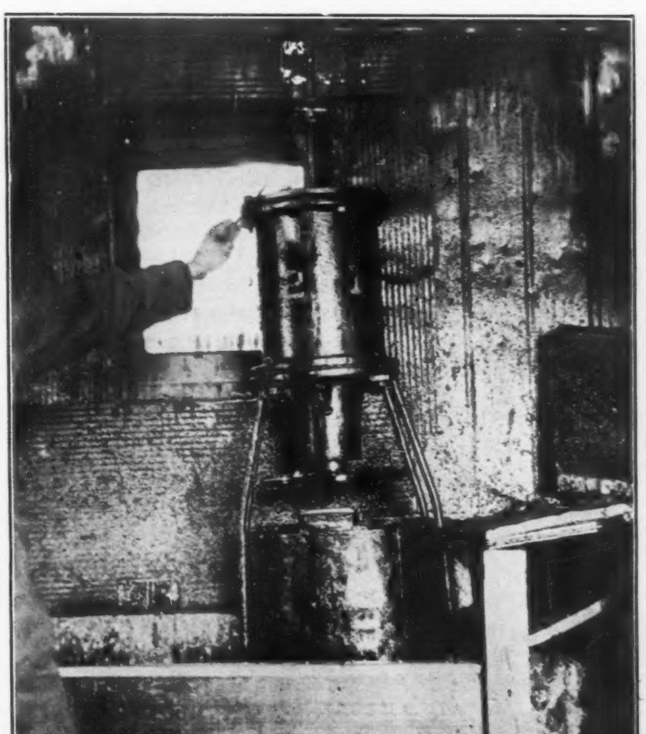
In fitting up air hose, we are informed by the *Atlantic Coast Line News*, one of the most important operations is to properly apply the clamps and to bolt them securely and without delay. In the past, by the means then employed, it was possible to take care of from 15 to 20 hose per hour. But as the activities of the road increased, it was recognized that something would have to be done to speed up the work of properly clamping and bolting air hose.

The outcome was a very simple machine, designed by the air-brake department of the Emerson Shops of the Atlantic Coast Line Railroad Company. The clamping is done by a scissors-type arrangement with jaws that fit around the clamp—a 6-inch air cylinder, provided with a foot pedal, admitting the air as needed. When air at a suitable pressure is fed to the cylinder, the piston moves upward. This causes the jaws to come together, closing the clamp uniformly around the hose and leaving free the ends of the clamp for the adjustment of the bolt. A small hand-operated crank socket is attached to the device close to one of the jaws for the purpose of quickly running up and tightening the nut. By means of this machine it is now possible to properly clamp and bolt 60 air hose an hour.

The second application of compressed air of a novel order is that conceived in the car department of the Denver & Rio Grande Western Railroad in connection with the work of renovating packing for journal boxes. On this subject, the *Railway Mechanical Engineer* says: "Hot boxes are costing the railroads thousands of dollars yearly, the greater portion of which might be saved by employing men skilled in journal lubrication and by proper renovation." In other words, before replacing old packing in journal boxes it should be thoroughly washed in hot oil to get rid of all foreign matter, especially the fine particles of grit that are otherwise apt to cut the journals.

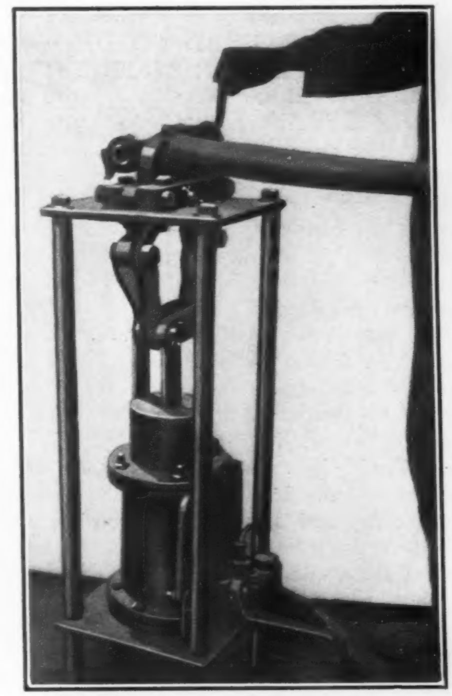
This work is now being done in the car department at Denver by the aid of an air press rigged up from an old air-brake cylinder. Upon removal from the journal boxes, the packing is allowed to remain on a warming table until it becomes pliant. It is then placed in a large steel tank in which is secured, several inches above the bottom, a half-inch mesh screen. Oil, warmed by steam pipes beneath the tank, covers this screen to a depth of a few inches.

After the packing in the tank has been stirred well it is put in a double bucket and pressed. The inner section of this bucket, which is fastened by long bolts to the brake cylinder above it, is perforated with small holes while the outer section is bottomless. The remaining oil and foreign matter is squeezed out of the packing by a circular plate of steel attached to the threaded piston —a cut-off valve, with a small vent hole in one side, applying and releasing the compressed air that is admitted into the top of the cylinder through a pipe connection tapping the main air line. This thorough cleansing of the packing is said to have reduced considerably the number of hot boxes occurring on the Denver & Rio Grande Western line.



Courtesy, Railway Mechanical Engineer.

An air-brake cylinder rigged up for use in renovating journal packings.



Courtesy, Atlantic Coast Line News.

This apparatus can clamp and bolt 60 air hose an hour.

AIR OPERATES LOCOMOTIVE TEST SCALES

BEFORE leaving the shops, the electric locomotives manufactured by the General Electric Company must undergo thorough testing. This work is done at the Erie Works, where there is a suitably equipped 5-mile test track on which can also be made certain comparative studies of steam and electric locomotives.

Among other things, the work involves the weighing of the locomotives. This is accomplished by means of a pit scale that makes it possible to determine the total weight and, by the use of individual scales for each pair of wheels, the weight on each wheel. The load is thrown on the scales by the aid of an air-operated mechanism that either raises the wheels singly or the whole locomotive, as desired.

A new automatic camera has been built by the Fairchild Aerial Camera Corporation of New York that will enable a pilot, flying at an altitude of 15,000 feet, to map an area of 180 square miles on one roll of film.

The City of Osaka, with a population of 2,115,000, is Japan's principal manufacturing center.

AIR DRILL USED TO DRIVE COMMUTATOR SLOTTER

AIR-DRIVEN drills are handy tools not only for drilling holes—the work for which they were designed—but for operating other mechanisms. In these pages we have, on numerous occasions, shown the air drill serving as a source of power—a tribute to its adaptability. It should therefore be of interest to our readers to hear of still another instance of this kind.

We learn from the *Electric Railway Journal* that an air drill is the prime mover for an improvised commutator slotting machine rigged up for emergency use in one of the shops of the Interborough Rapid Transit Company of New York City. The slotting machine consists of a sturdy base upon which are mounted a stationary and a movable bearing for the support and the rotation of the armature. On top of the stationary bearing is mounted the slotting mechanism, consisting of a sliding base for horizontal motion, a slide for vertical motion, and a hand-operated air drill with an extended shaft and saw.

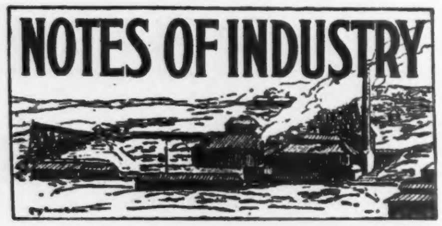
The drill is securely fastened to the vertical slide, and the saw shaft is kept in alignment by a suitable bearing. A fiber shield is interposed between the drill and the saw to prevent the exhaust air from scattering the copper and mica dust. Directly over the saw is a suction hose to carry away the copper and mica dust as it is developed during the slotting process. The depth of the slot is governed by the vertical slide, which is controlled by a hand wheel, while the movement of the saw through the slot is controlled by a hand lever.

RUBBER-PLATED GOODS A POSSIBILITY

A REVOLUTIONARY change in the rubber industry is predicted as the result of a newly developed process of manufacture that is based on the same principle that is involved in the electroplating of metals. In other words, the announcement comes from Akron, Ohio, that rubber-plated commodities—such as overshoes, gloves, bathing caps, automobile tires, and the like—have been made that possess greater strength and elasticity than the goods produced by the older methods.

The new process is the outcome of pure research, conducted by Dr. S. E. Sheppard. By using an electrolytic solution containing minute particles of rubber, Doctor Sheppard has succeeded in depositing rubber on the anode of an electric circuit. In practice, the anode serves as a mold or form on which the rubber is deposited. It is claimed that molds of this description, and of any shape and size, can be plated with rubber as thin as a piece of tissue paper or as thick as a brick wall.

Just how much more room we have than other nations for expansion is strikingly brought out by the following figures: There are 39 persons to the square mile in the United States; Germany has 335; Great Britain and Italy, 352; Holland, 590; and Belgium has a population of 649 to the square mile.



We are convinced now that heavy-oil engines are adaptable, for word has come from the Orange Free State that a Diesel engine, used there to pump water for irrigating purposes, is run on whale oil. The change in fuel has called for no alteration in the engine, which is operating satisfactorily.

New York City is the superpower city of the world both in the matter of power production and power utilization. The combined output of her generating plants now exceeds 2,800,000 H.P., which is more than double the capacity of the power plants at Niagara Falls.

According to a statement issued by the Du-Pont Company, one of its subsidiaries is prepared to manufacture methanol—chemically pure wood alcohol—on a commercial scale. This is the first attempt of the kind in the United States, and is the result of two years of intensive laboratory work. The process is a strictly American one. About 6,000,000 gallons of methanol is used annually in this country in the making of dyestuffs, lacquers, celluloid, Bakelite, and in other products.

The Bethlehem Steel Company has recently cast an ingot mold that weighs 191 tons. The ingot to be poured in this huge mold will weigh, in the rough, 50 tons more than that.

Although it leads the world as a consumer of tin, the United States produces very little of this metal. In 1925, in addition to importations of 76,646 tons of metallic tin, 27,633 tons were made available for use by recovery processes. Against this total of 104,279 tons, the mines of this country yielded only 12.3 tons of tin. Despite this lack of a domestic supply, the tin-plate industry of this country is in the forefront with an output of more than 40,000,000 tin boxes annually.

Pressed fire bricks made of calcium phosphate are said to possess great heat-resisting properties. Tests of refractory bricks of this description, produced in Holland, have proved them to be a superior product.

Paint-spraying machines may soon be used on the Clyde—Britain's great shipbuilding center.

Oil has been discovered by the Japanese on the Island of Sakhalin—the first test well bringing in about 2,000 barrels per day.

The latest statistics reveal that there are now in use in the United States more than 22,000,000 motor cars, or one for every five persons.

The Esthonian Government has granted a concession to Swedish interests for the breaking up of 1,000,000,000 tons of oil shale. A pilot retorting plant is under construction and will be run for a year to determine the best methods to be employed for the commercial extraction of oil from the shale. It is planned at the start to treat 50,000 tons of shale annually; and efforts will be made to produce benzine, lubricating oils, and fuel oils by distillation. The Esthonian oil-shale deposits amount to many billions of tons, and are rated among the richest known.

To conserve gasoline, both the Italian and the French Governments have decreed that all gasoline consumed in those countries must be diluted with a certain percentage of alcohol.

It is authoritatively reported that only 6 per cent. of the families in the United States use ice the year round. Yet the output of manufactured ice in this country exceeded 40,000,000 tons in 1926.

It is reported by cable that a French marine engineer, Raoul Ferrier, has discovered a substance that will make gasoline noninflammable.

According to the *Engineer*, a German industrial plant has found a system of vacuum cups an improvement over slings now commonly employed in handling non-magnetic plates with an overhead crane. A vacuum of from 0.1 to 0.5 atmospheres is used, depending on the weight of the material to be lifted.

Official reports from the Department of Commerce show a steady increase in machinery exports from the United States. During January of this year there was exported industrial machinery to the value of $14,946,842—making it the best month but one since 1921. Power-generating, metal-working, and oil-well machinery showed the greatest gain.

An aero-sleigh has been invented in Russia that promises considerably to improve transportation in northern countries.

The underground high-voltage cable that is to be used in hooking up Chicago's electric generating stations embodies new principles of insulation, so we learn from *Copper & Brass Bulletin*. The so-called superpower cable, which is now being made, consists of a hollow core surrounded by copper wires and 100 layers of paper. The core is to be filled with thin oil that will be kept under pressure and thus impregnate the paper. So insulated, the cable will be capable of carrying safely a current of more than 130,000 volts.

Approximately 5,000,000 tons of lime, valued at $46,500,000, was produced in the United States in 1926. Out of the 115 industries in this country that require lime for one purpose or another, the chemical industry consumed 45 per cent. of last year's output.

Compressed Air Magazine

—*Founded* 1896—

Devoted to the mechanical arts in general, especially to all useful applications of compressed air and to everything pneumatic.

Business and Editorial Offices:

Bowling Green Building, No. 11, Broadway, New York City. Tel. Bowling Green, 8430

Publication Office: Somerville, New Jersey

TERMS OF SUBSCRIPTION

$3 a year, U. S. A., American possessions and Mexico; all other countries $3.50 a year, postage prepaid. Single copies, 35 cents. Back issues more than six months old, 75 cents each.

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EDITORIALS

RAILWAY FOR BERMUDA

WE are generally familiar with the stand maintained for years by the civil authorities of the Island of Nantucket against the intrusion of the power-driven vehicle. Nantucket pointed with pride to its historical background and the figure it had cut in making America's whaling industry notable the world over. Somehow, so the governing powers thought, the automobile did not fit into that ancient setting; and as long as they could they prevented the introduction of the motor car. Inevitably, the summer populace—which figures so greatly in Nantucket's economic life—compelled a change and the lowering of the barriers raised against the automobile.

Bermuda—also historic and a picturesque haven for many thousands of American tourists—has long stood rigidly opposed to innovations that might speed up existing methods of conveyance. The Bermudians preferred to make their leisurely ways about or around the island by horse-drawn vehicles or by boats, depending upon whether the journey were made overland or by water. The only concession made to modern progress was the favor shown the bicyclist. The motor car was absolutely interdicted. But, again, circumstances forced a change, and a few motor trucks were admitted to the island to do a measure of the heavy hauling.

Wonder of wonders! Bermuda is now to have a single-track railroad 24 miles long—in other words, the line is to run from end to end or from side to side of the island, according to the way in which you look at it. This railroad is the outcome of years of agitation, and is the direct result of an investigation authorized by the Bermuda Assembly in 1920. The purpose of the investigation was to ascertain the feasibility of such a system of transportation. The line is to be built by a New York concern, and is to be completed within a year's time at an outlay of $2,000,000.

People familiar with the placid, easy-going, yet withal industrious life of Bermuda will no doubt speculate as to the ultimate effect of a railroad upon the social and the economic habits of the genial Bermudians. One thing is certain, even that island paradise could not oppose effectually the irresistible march of modern progress. In this recognition of the inevitable we have another confirmation of the Reverend Jasper's wise conclusion: "The sun do move!"

NEW YORK CITY TO HAVE MORE WATER

THE responsible municipal body, the Board of Estimate of the City of Greater New York, has duly committed itself by recent action to the construction of a tunnel and an aqueduct that will call for an outlay of $64,000,000. By these means the rapidly increasing population of the boroughs of the Bronx, Brooklyn, and Queens will have at its disposal a greatly amplified water supply.

This splendid project, recommended first by the Commissioner of Water Supply in 1921, has been kept in abeyance until conditions emphasized the need of obligating so large a sum of money. It is estimated that the work will call for approximately seven years of continuous labor. The tunnel—which will be driven through rock—will have a diameter of 17 feet throughout the greater part of its length.

The new water line will extend from Hillview Reservoir, in Yonkers, through the Bronx to the East River; under the East River, near Hell Gate, to Astoria, in Queens; and thence to Fort Greene Park, in Brooklyn, where it will connect by an existing shaft with the present water-supply system of that borough. The rock tunnel, in the course of its driving, will have but few surface evidences to tell the story of the momentous work that is going on underground. At points, the tunnel will be fully 500 feet below the surface. Air-driven rock drills will have a prime part to play in helping in this way to fill New York's cup to overflowing.

FRANCE CONFRONTED BY AN IMMIGRATION PROBLEM

WHAT the United States has done towards restricting immigration has made her the target of much foreign criticism. Apart from the fact that we were closing our gates to the world, instead of leaving them wide open as had so long been the case, we were purposely turning away an alien tide which had contributed both brains and brawn—mostly brawn—especially in the latter-day upbuilding of the nation when native labor was lacking to do the multiplying manual tasks essential to our prosperity.

Without discussing the wisdom or the unwisdom of our course in restricting immigration in recent years, it is sufficient to remark here that immigration, like any other social or industrial problem, is a matter that has changing aspects agreeably to changing conditions. These controlling factors are not peculiar to any nation; and now France is face to face with the question of how to limit and even how to exclude alien peoples that have been so essential to her rapid rehabilitation after suffering the ravages of the World War.

Whenever the time arrives in any country that it is no longer possible for most of the people to have gainful employment, and a considerable percentage of them is idle, then an economic condition arises that leads to more or less grave concern. The situation becomes all the more grave when many of the employed are foreigners and their employment takes work and the means of livelihood from the native born.

It has been stated a few weeks back by the President of France that there were fully 1,450,000 foreign workers in France—the greater number of them probably being there in response to the call for foreign labor during the height of the reconstruction period. Economic conditions are such today that these workers force hardships upon their French competitors for existing opportunities of employment and also impose hardships upon the alien residents who are out of work. In short, the reciprocal reactions tend to lower the general standard of life and the spirit of content. France's present problem may make our critics more temperate in their judgment of us.

HOME OWNERS MAKE BETTER EMPLOYEES

THIS is the opinion earnestly expressed by the general manager of one of America's large industrial enterprises. That organization has 6,800 men and women on its pay roll; and upon all possible occasions these workers are urged to own their own homes. Today, 2,482 of the employees of that company own their homes.

This figure is rightly considered remarkable in view of the large number of young men and young women employed. It seems that fully 50 per cent. of the employees who are heads of families own their homes. In a statement commending the workers upon their unusual home-ownership record, the manager had this to say:

"One who is thrifty in his own affairs can be depended upon to be thrifty in the interests of others. The fact that so many of you own your homes marks you as men and women of the highest type. There are so many places for the spending of money that the saving of it rather than the making demonstrates managerial ability. A great responsibility is upon the wife as to how much can be saved each year. Good management must come from the coöperation of man and wife, and not from the efforts of one alone."

This experience of one large industrial organization is probably not unlike that of other concerns. The home owner is unquestionably apt to prove not only a stabler and more valuable employee but likewise a more worthwhile factor in the community of which he forms a part.

FAMOUS CREIGHTON NICKEL MINE ECLIPSED

THE famous Creighton Mine, which has had the reputation of being the world's greatest nickel producer, will be far overshadowed by the Frood Mine which, according to a statement by Lloyd J. Moore, financial editor of the *Toronto Globe,* will be brought into production in about 1931. Both mines are the property of the International Nickel Company of Canada.

To quote Mr. Moore: "The history of the Frood is a more than ordinarily interesting one. The existence of the mine has been known for over 30 years. Nearly 20 years ago some shallow drifting was done, and this showed low-grade ore only. In 1923 it was decided to do some deeper drilling, and this showed that the Frood would outdistance all its rivals among the nickel-producing mines of the world. Its ore reserves are easily ten times as great as those of the Creighton today—a conservative estimate having placed them at 100,000,000 tons. The metallic content of the ore is slightly less than that of the Creighton, but there is a large percentage of copper and fully three times as much platinum. Even in these days of big mines, the Frood is considered remarkable."

USE OF FUEL OIL UNDER LOCOMOTIVE BOILERS

THE development of the oil-burning locomotive is characterized as a strictly American achievement in a review on the subject by the United States Department of Commerce. Experimentation in the burning of oil under locomotive boilers began soon after the initial discovery of petroleum in Pennsylvania in 1859. In those days, however, the high price of fuel oil, as compared to that of coal, retarded the general adoption of oil in that field of service.

It is significant to note that the first road to carry on extensive experiments along this line was one in California. At that time, 1879, no oil fields had been exploited in the western part of the country; and the oil used had to be transported by water from the Atlantic coast. Since 1906, the Southern Pacific Railroad has burned oil exclusively under its locomotive boilers, while other roads in different parts of the states utilize oil burners to some extent.

CONCRETE ROADBUILDING IN THE UNITED STATES

THE concrete road, now the delight of the motorist, might almost be called a postwar development. *Commerce Monthly* is responsible for the statement that in 1909 there were only 3 miles of concrete highways in the United States. By 1917 there were less than 3,500 miles; and at the end of 1925 this total had been increased to 37,000 miles.

Just how extensively we have gone in for concrete roads can, perhaps, be better appreciated when it is realized that more Portland cement is used for road and street paving than for any other purpose—in excess of 40,000,000 barrels now being required in this field annually.

THE RAYON INDUSTRY, by Mois H. Avram, B.Sc., M. E. A work of 622 pages, with 171 illustrations, published by D. Van Nostrand Company, New York City. Price, $10.00.

PROBABLY no more fascinating page in the history of textiles will be written than that having to do with the development of the rayon industry—an industry that owes its present really amazing proportions to the joint labors of the chemical and the mechanical engineer who have made it possible for man to do on a steadily increasing scale what Nature's myriads of silk worms have been relied upon to do in the centuries gone. In 1900, only one factory existed for the manufacture of so-called artificial silk, and the output was but a few thousand pounds of the textile. In 1925 there were substantially 100 factories turning out this material, and the production totaled 172,000,000 pounds in the course of that year!

As far back as 1754, Réaumur, a French physicist, in his classical work *History of Insects,* expressed the belief that man would be able to imitate the silk worm. As he put it: "Silk is only a liquid gum which has been dried. Could we not make silk ourselves with gums and resins? This idea, which at first sight might appear fanciful, is more promising when examined closely." Réaumur proposed the use of varnishes that could be drawn out into fine filaments and then spun into thread. At that time no suitable varnish was available; and the industry foreseen by Réaumur had to wait until nitrocellulose was discovered nearly a century later and found to possess many potentialities.

Count Hilaire de Chardonnet is the man that really placed the making of artificial silk upon a commercial foundation; and, because of his work, first crowned with success in 1884, he is known as the "Father of the Artificial Silk Industry." We commend heartily to anyone interested in the history and the technique of rayon this really admirable book that Mr. Avram has written.

A NATION PLAN, by Cyrus Kehr. An illustrated volume of 210 pages, published by American Branch, Oxford University Press, New York City. Price, $5.00.

WITH a discerning eye looking toward the future, Mr. Kehr envisions the logical and broader—far broader—application of the principles underlying city planning. In other words, he points out with convincing clarity that it is essential to the interest of the generations to come to think of a nation's development in much the same manner that experts now give thought to the planning of municipalities so that the masses may enjoy healthful and inspiring surroundings and be able to get to and from their places of business with all practicable dispatch.

It is fresh in the minds of many thousands of us how large a percentage of us was skeptical a few years ago when the theme of city planning was first advanced by its advocates. Most of us had entertained a curiously narrow or local idea of the city or cities in which we lived, and we found it hard to understand how the block in which we lived should concern itself about those hundreds of other blocks that form integral parts of the city as an entirety. We have since realized that any growing community would be far better fitted for the needs of the years to come if it could be laid out and its various parts and communal activities coördinated so that the demands of the future could be anticipated and properly provided for.

The author has set himself the task of showing how the lessons learned latterly in city planning can be adapted on a grander scale and for the same common good in the case of a nation. Among the topics treated in this excellent book are: the improvement of transportation, including highways, waterways, railways, and seaports; the resulting better distribution of population and industries; the "zoning" of immigrants and the handling of surplus labor; the promotion of conservation; and the relation of all these to social betterment. This volume should prove of interest to a wide circle of readers. It has a fine inspirational quality.

TROPICAL CYCLONES, by Isaac Monroe Kline, Senior Meteorologist, U. S. Weather Bureau. An illustrated work of 301 pages, published by The Macmillan Company, New York City. Price, $5.00.

THIS book will prove of lasting value because of the large amount of original matter contained in its pages and because the author has arrayed many of his facts in a new and illuminating manner. He has carefully traced and coördinated data concerning tropical cyclones for the last quarter century, and has laid the foundation for the study of these atmospheric disturbances in a way that may prove of enduring benefit.

Tropical cyclones not infrequently develop wind velocities of 100 to 140 miles an hour—with even greater velocities occasionally in certain parts of the cyclonic area. As is well known, storms of this sort may cause great destruction to shipping in the open seas and to all classes of structures lying within their paths. A single tropical cyclone has taken as many as 6,000 human lives. Therefore, it is of vital importance to know as much as possible about the origin, the probable movements, and the physical characteristics of storms of this sort so as to guard against their ravages as far as it may be practicable to do so.

Fifty Years of Service is the title of an illustrated booklet of 168 pages recently issued by the Western Wheeled Scraper Company of Aurora, Ill. The booklet is a historical review of the company and its splendid development since 1877. As might be expected, a large share of the pages illustrate and describe the present-day products of this experienced concern.

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